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# TECHNICAL MEMORANDUM LOWER AQUIFER INVESTIGATION REPORT

AMERICAN CHEMICAL SERVICE, INC.  
NPL SITE  
GRIFFITH, INDIANA

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*PREPARED FOR:*  
ACS RD/RA EXECUTIVE COMMITTEE

• • •  
*PREPARED BY:*  
MONTGOMERY WATSON  
ADDISON, ILLINOIS

MARCH 1997



**MONTGOMERY WATSON**



**MONTGOMERY WATSON**

March 28, 1997

Ms. Sheri Bianchin, RPM  
Mail Code SR-J6  
U.S. EPA, Region V  
77 West Jackson Blvd.  
Chicago, IL 60604-3590

Response to: Approval of the Lower Aquifer Technical  
Memorandum with Modifications;  
American Chemical Service, Inc.,  
NPL Superfund Site, Griffith, Indiana

Dear Ms. Bianchin:

This letter is written in response to your letter entitled: "Approval of the Lower Aquifer Technical Memorandum with Modifications; American Chemical Service, Inc., NPL Superfund Site, Griffith, Indiana," dated March 3, 1997. With this letter, replacement pages for the five copies of the previously submitted Technical Memorandum are enclosed.

The following is a transcription of the U.S. EPA comments enclosure, with our direct responses to each U.S. EPA comment.

**ENCLOSURE**

**U.S. EPA Required Modifications to  
Lower Aquifer Investigation Technical Memorandum  
(dated September 1996) for American Chemical Services, Inc.,  
NPL Superfund Site, Griffith, Indiana**

**1. General Comment.**

Document that sampling and analysis will be conducted in accordance with the approved SOPs. Add the appropriate SOPs to the document. Also, revise Section IV of the approved SOP, Sample Collection and Preparation, to indicate that a 2 micron filter shall be used in future sampling events instead of the 0.45 micron filter for collection of groundwater for dissolved metals analysis. U.S. EPA believes that the larger filter will yield more representative results. See also comment 15 below.

A statement that sampling and analysis will be conducted in accordance with the approved SOPs is included in Section 7.4 of the revised Technical Memorandum. The U.S. EPA approved Specific Operating Procedure: Low Flow Groundwater Sampling has been added as Appendix O.

U.S. EPA's sampling requirement was to analyze non-filtered groundwater samples for total metals. The ACS Group voluntarily collected sample volume, filtered it, and analyzed it for dissolved metals during previous sampling events. Rather than modify the method, the ACS Group has elected to discontinue the voluntary filtering and analysis for dissolved metals. The non-filtered groundwater samples will continue to be analyzed for metals in accordance with the U.S. EPA's sampling requirement.

**2. General Comment.**

Upon U.S. EPA's review of the recent submittal of the first quarterly monitoring report dated January 31, 1997, U.S. EPA acknowledges the significant increase in the benzene concentration in MW-9. This possibility was discussed with Respondents in previous meetings. This finding will need further investigation. U.S. EPA hereby requires that the analytical results from the next quarterly sampling event from MW-9 be provided to U.S. EPA on an expedited basis, along with a proposal for U.S. EPA approval for investigating the contamination at MW-9. Provide a date by which U.S. EPA can expect to see this information and proposal.

Montgomery Watson is currently developing a plan for further investigation at MW9. The sample from Monitoring Well MW9 will be submitted for expedited laboratory analysis. Both the plan for further investigation and the sampling results will be provided to U.S. EPA by April 30, 1997. Section 7.4.2 of the Technical Memorandum has been revised to reflect this.

**3. Page ES-1, Executive Summary, Paragraph 4.**

The text states, "The thickness of the upper clay confining layer varies from 4 feet to 35 feet to the south." Revise the text to state the following: the thickness of the upper clay confining layer varies from 2.5 feet to 35 feet.

The text in the executive summary has been modified as requested.

**4. Page ES-2, Executive Summary, Paragraph 2.**

The text states that the total VOC concentrations (of) approximately 14 µg/l were found in lower aquifer water

collected from two 2 ACS production wells (IW1 and IW4). According to Table 9, a sample from IW1 contained 14 µg/l of acetone, 11 µg/l of 2-butanone and a total of 24 µg/l of other VOCs at estimated concentrations. A total of 49 µg/l is not approximately 14 µg/l. Please revise accordingly.

**The text in the executive summary has been modified to include the detected concentrations and a statement regarding estimated concentrations in IW1 and IW4.**

**5. Page ES-2, Executive Summary, Paragraph 4.**

The text states, "Except for the phthalate anomaly, there were no exceedances of remediation levels in samples collected at the downgradient site boundary..." According to Table 8 of the LATM, both manganese and thallium exceed remediation levels in MW-33, located at the downgradient site boundary. Revise the statement accordingly.

**The text in the executive summary has been modified to include the detections of manganese and thallium at MW33.**

**6. Page 9, Section 2.5, Monitoring Well Sampling.**

In the future, the dissolved metals analysis samples should be filtered using an in-line filtering device as specified in the approved SOPs. It is not clear why the sampling done during this field effort used incompatible tubing and samplers were not prepared with the appropriate tubing adaptors/connectors.

**Because filtered samples will not be collected for dissolved metals analyses, future filtering will not be required.**

**7. Page 10, Section 3.1.1, Upper Aquifer.**

The text states that the upper aquifer thickness varies from 27.5 to 13.5 feet, whereas in the Upper Aquifer Tech Memo (October 1996), Section 3.1, states that it varies from 17 to 11 feet. Revise the documents so that they are accurate and concur with one another.

**The text in the Upper Aquifer Technical Memorandum states that the "thickness of the upper aquifer encountered during this investigation ranged from approximately 11 feet at several locations to 17 feet at MW43," which is true. Both Upper and Lower Aquifer Technical Memoranda have been modified to**

indicate the upper aquifer thickness at the site varies between approximately 13 feet and 28 feet.

8. **Page 10, Section 3.1.1, Upper Aquifer.**

The last sentence of this section lacks a period.

**Additional text to clarify the thickness of the upper aquifer and a period have been added to the last sentence in Section 3.1.1.**

9. **Page 10, Section 3.1.2, Upper Clay Confining Layer.**

Soil boring CB-1 is now included in the discussion. Please assure that the location of this boring appears on relevant figures.

**Soil boring CB-1 was apparently made in the northern part of the site but boring log CB-1 does not have specific coordinates on it. Since our records do not provide a specific location for the boring, we have been unable to plot its exact location on a site base map. Our best information indicates that it was installed near MW10C, as mentioned in the text.**

10. **Page 11, Section 3.1.2, Upper Clay Confining Layer, Paragraph 4.**

Revise the last sentence to state the following: At the northern side of the site, the clay thickness was 2.5 and 4.0 feet at CB-1 and MW-33, respectively.

**The text in section 3.1.2 has been modified as requested.**

11. **Page 14, Section 3.4, Groundwater Flow Direction.**

The last sentence of this section makes an unnecessary and unsubstantiated (based on gradients) assertion and should be removed. If an argument is to be made regarding significant flow directions; more information would need to be included in the argument.

**We feel that the concept stated by this last sentence is necessary to a complete discussion of the groundwater flow system in the lower aquifer. The text has been expanded to provide the additional substantiation required by U.S. EPA.**

12. **Page 15, Section 3.5, Continuous Water Level Measurements, Paragraph 4.**

The text states that an increase in hydraulic head is noted over the last four days of continuous monitoring (February 27 through March 2). A 0.95-inch rainfall event occurring on Tuesday, February 27, may explain this increase in hydraulic head. This data was provided by the City of Gary, Air & Land Pollution Control Department. Revise the document accordingly.

**The requested information has been added to Section 3.5.**

13. **Page 17, Section 4.2, Laboratory Analytical Results.**

SVOC exceedances appear in Table 8B, not Table 8A.

**The reference has been modified in the text of Section 4.2**

14. **Page 24, Section 6.1, Private Well Search.**

The wells mentioned in the first paragraph on page 25 are listed by letter (not number) in Table 11, and Figure 8.

**Table 11 has been revised to reflect well designation by letter, to correspond to Figure 8 designations.**

15. **Page 26, Section 6.2.3, Inorganic Results.**

The usual protocol for residential well samples is total metals. Since the homeowner does not filter their water before using the water, a filtered sample seems unnecessary. As EPA previously stated, only the unfiltered sample is required. If Respondents continue to want to collect a filtered groundwater for dissolved metal analysis, U.S. EPA recommends that a 2 micron filter (or larger) be used rather than the 0.45 micron filter as is stated in comment 1 above. Revise the SOP accordingly.

**The ACS Group will not collect filtered groundwater samples during the March 1997 sampling event. The text of Section 6.2.3 has been revised to reflect this. The SOP has been modified to remove the section regarding filtration of samples.**

**16. Page 26, Section 6.2.3, Inorganic Results.**

Please provide an explanation for the high inorganic analyte concentrations detected in sample PW02.

**The sample from PW02 has elevated inorganic concentrations because it contains more dissolved solids than other private well samples that were analyzed. There are many possible reasons for these elevated inorganic concentrations, including a malfunctioning pump, poor filter pack, leakage from the upper aquifer to the lower aquifer along the borehole in which the well is located, or incursion into the well by insects, a toad, or a small mammal. Rather than speculating which if these has been the cause, we have added the general statement that water from PW02 contains more dissolved solids than the water from other private wells.**

**17. Page 28, Section 7.1, Conclusions, Item 2.**

Revise the text to state: The upper clay confining layer varies in thickness from 35 feet to the south to 2.5 feet to the north.

**The text is revised as requested.**

**18. Page 28, Section 7.1, Conclusions.**

The second sentence of bullet 6 should be revised to reflect the corrected hydraulic gradients. The horizontal gradient is not 1.5 to 5 times greater than the vertical gradient. Based on Table 6, the vertical gradient is generally larger than the horizontal gradient; at several locations an order of magnitude greater. Please revise accordingly.

**In response to the U.S. EPA comment, the second sentence has been deleted from conclusion #6.**

**See response to comment #11 above. Since vertical gradients are calculated from groundwater elevation differences that are relatively close to the margin of potential measurement error, the calculated vertical gradients are anomalously high. Furthermore, sixty percent of the calculated vertical gradients are equivalent to zero. Therefore, there is little technical justification for comparing the magnitude of vertical to horizontal hydraulic gradients, and such comparison will not be mentioned in the text.**

19. **Page 29, Section 7.1, Conclusions.**

Bullet 14 states that VOC concentration (of) approximately 14 µg/l were found in samples from 2 ACS production wells. According to Table 9, a sample from IW1 contained 14 µg/l of acetone, 11 µg/l of 2-Butanone and a total of 24 µg/l of other VOCs at estimated concentrations. A total of 49 µg/l is not approximately 14 µg/l. Please revise accordingly. Also, indicate which two wells are referred to in the text (i.e., IW1 and IW-4).

**The requested modifications have been made to conclusion #14 in Section 7.1.**

20. **Page 31, Section 7.3.1.1, ACS Production Wells, Sounding Measurements.**

State how long is anticipated between pump removal and water level measurements. It is important to allow sufficient time for water levels to recover after pump removal before measuring the static water level.

**Because the wells are installed in a highly productive aquifer, the recovery will be virtually instantaneous following removal of the pumps and piping. Sounding the total depth of the well will take approximately 15 minutes. Therefore, a water level measured after the total depth sounding will be a valid static water level. The text in Section 7.3.1.1 has been revised to reflect this.**

This section proposes several monitoring wells and piezometers for water level measurements concurrent with water level measurements for the production wells. In addition, water level measurement from four additional wells, MW4D, P34, P36, and P39 must also be collected which are also located in the vicinity of the production wells.

**In Section 7.3.1.1 of the Lower Aquifer Technical Memorandum, MW4D, P34, P36, and P39 have been added to the list of wells and piezometers for collecting water levels concurrent with production well level measurements. However, it may not be possible to collect a water level from MW4D, because the well belongs to the Town of Griffith, and they may or may not grant access to this well.**



21. **Page 31, Section 7.3.1.3, ACS Production Wells, Sampling.**

a. Based on the discussions carried out in meetings with U.S. EPA, the sampling of the production wells IW1, IW2, IW3 and IW4, was to be conducted by isolating the zone of interest with a packer assembly. Sampling of IW1, 2, 3 and 4 should be done using a packer assembly to collect samples of water from the discrete interval where the casing is seated in the bedrock. Only if the caliper logging reveals a highly disturbed interval where the packers would be seated (making packer inflation and recovery problematic); would sampling without the packers be acceptable to U.S. EPA. Revise Section 7.3.1.3 to include this approach.

**The text in Section 7.3.1.3 has been modified as requested.**

b. The sampling protocol proposed here is not a standard sampling protocol (involving higher pumping rates for a short purge period followed by low stress sampling). Sampling should be done following standard low flow/low stress sampling protocols (such as the July 1996, Upper Aquifer Investigation Groundwater Monitoring Well Sampling SOP).

**To the degree possible through a packer system, standard low flow sampling methods will be followed as described in the approved groundwater sampling SOP protocol.**

c. Upon completion of the sampling of production wells IW1, IW2, IW3, and IW4, the U.S. EPA requires time to review the resulting analytical data, prior to well abandonment. Respondents can request an expedited turn-around on sample analysis, and U.S. EPA will commit to an expedited review. Revise Section 7.3.1.3 to include this approach.

Once the wells are abandoned, it will not be possible to resample the wells if something goes wrong (e.g., samples are lost, holding times are violated, analytical problems at the laboratory occur which compromise data quality).

**Three samples will be collected from the production wells for TCL and TAL analyses. Once sample volume will be provided to U.S. EPA for a split sample. The second sample volume will be sent to the laboratory for analysis. The third sample will be stored at 4°C in an on-site refrigerator pending receipt of the**

second sample by the laboratory. Once the laboratory has confirmed that they have all the sample containers and are able to extract the appropriate sample volumes for analysis, the third sample will be discard.

**22. Page 34, Section 7.3.2, Closed Production Wells IW5 and IW6.**

a. Please clarify that if a floating free-phase product is found in IW-6, it will be collected and analyzed for TCL parameters.

**The text of Section 7.3.2 has been modified as requested by U.S. EPA.**

b. Discuss how long is anticipated after sampling of IW5 and IW6 and before well abandonment. Upon completion of the sampling of production wells IW5 and IW6, the U.S. EPA requires time to review the resulting analytical data, prior to well abandonment. Respondents can request an expedited turn-around on sample analysis, and U.S. EPA will commit to an expedited review. Revise Section 7.3.2 to include this approach. It is important that U.S. EPA be assured that the samples are analyzed.

Once the wells are abandoned, it will not be possible to resample the wells if something goes wrong (e.g., samples are lost, holding times are violated, analytical problems at the laboratory occur which compromise data quality). It is for this reason that U.S. EPA has recommended abandonment after sample results have been received.

**Three samples will be collected from the production wells for TCL and TAL analyses. Once sample volume will be provided to U.S. EPA for a split sample. The second sample volume will be sent to the laboratory for analysis. The third sample will be stored at 4°C in an on-site refrigerator pending receipt of the second sample by the laboratory. Once the laboratory has confirmed that they have all the sample containers and are able to extract the appropriate sample volumes for analysis, the third sample will be discard.**

**23. Page 34, Section 7.3.2.3, Closed Production Wells, Sampling.**

According to U.S. EPA-approved sampling procedures for ACS, sampling of groundwater is to be conducted with pumps, not bailers. Revise this section to include sampling with a pump.

We understand that the U.S. EPA has a preference for collecting samples from monitoring wells with a pump rather than a bailer because a pump is more likely to collect a sample that is representative of the aquifer. However, wells IW5 and IW6 are not monitoring wells and they are unlikely to produce groundwater representative of the aquifer, whether they are sampled with a pump or a bailer.

On the other hand, there is good reason to use a disposable bailer for purging and sampling. The wells appear to be highly contaminated. Whatever is lowered down the well will be seriously contaminated. It is likely that the \$1,000 pump would have to be junked after using it in a well that contains free product, or otherwise high levels of contamination. The text in Section 7.3.2.3 has been revised to reflect this.

**24. Page 34, Section 7.3.2.4, Closed Production Wells, Abandonment of IW5 and IW6.**

As discussed above, upon completion of the sampling of production wells IW5 and IW6, the U.S. EPA requires time to review the resulting analytical data, prior to well abandonment. U.S. EPA will commit to an expedited review. Revise Section 7.3.2.4 to include this approach.

Three samples will be collected from the production wells for TCL and TAL analyses. Once sample volume will be provided to U.S. EPA for a split sample. The second sample volume will be sent to the laboratory for analysis. The third sample will be stored at 4°C in an on-site refrigerator pending receipt of the second sample by the laboratory. Once the laboratory has confirmed that they have all the sample containers and are able to extract the appropriate sample volumes for analysis, abandonment procedures will be proceed.

**25. Page 35, Section 7.4.2, Lower Aquifer Monitoring Plan, Baseline Sampling, Monitoring Network.**

U.S. EPA has evaluated the proposal and the sampling schedule in Table 14 which shows a limited "target indicator list" for analytical parameters during 2 quarters of the first four consecutive quarters of the monitoring program. While it may be appropriate to consider a reduced parameter list (i.e., target indicator list) in the future, for the first four quarters (first year) of the monitoring program, U.S. EPA requires full TAL/TCL for the wells included in the monitoring program in order to establish a baseline. U.S. EPA would be amenable to considering reduced list of analytical

parameters and/or reduced sampling frequency for the second and subsequent years of the monitoring program (such as Table 14 suggests).

The monitoring network must be the same as was approved in U.S. EPA's October 11, 1996, correspondence: Approval with Modifications of the Proposed Upper Aquifer Monitoring Program. Regarding sampling of the wells (Section 6.2.4) in the southwest area, U.S. EPA's comment regarding the Griffith Municipal wells is still applicable.

To be clear, the following wells must be sampled during the quarterly monitoring events: MW-7, MW-8, MW-9, MW-10C, MW-21, MW-22, MW-23, MW-24, MW-28, MW-29, MW-30, MW-31, MW-32, MW-33, MW-34, MW-35, MW-36, MW-50, MW-51, MW-52, MW-53, MW-54, MW-55, and M4. All wells except MW-7 and MW-21 must be sampled for full-scan analyses, whereas MW-7 and MW-21 shall be sampled for TCL constituents. Revise the document to indicate this.

**Table 14 provides a summary of the wells to be sampled and the parameters to be analyzed in the March 1997 sampling event. One Griffith Landfill well (M4) is included on Table 14. It will be sampled if the Town of Griffith has granted access to the wells during the week of March 24, 1997. The ACS Group understands the importance of establishing an adequate groundwater monitoring baseline before reducing the list of parameters and number of wells included in the monitoring program. Therefore, the results of this sampling and previous sampling will be compiled and submitted to U.S. EPA for review.**

**26. Page 36, Section 7.4.3, Residential Well Drinking Water Sampling.**

Provide a brief summary of the residential wells samples collected to date. Enclosed is a table indicating the results from U.S. EPA's split samples results for the July 1996 residential well samples to include in the report.

**Section 7 of the Technical Memorandum is intended as the sampling plan. The results of previous sampling of residential wells is included in Section 6.2 of the Lower Aquifer Technical Memorandum. A reference to the private well sampling during the Remedial Investigation has been added to Section 6.2.**

27. **Page 36, Section 7.4.3, Residential Well Drinking Water Sampling.**

Given the fact that all of the well logs could not be located, and given the recent information regarding the off-site contamination, U.S. EPA requires that all residential wells on Reder Road be sampled during the next quarterly monitoring event (if access will be granted by the resident for that purpose). Also, the following residential wells should be sampled: 739 Arbogast, 1008 Arbogast, 1014 Arbogast, 1026 Arbogast, 430 Avenue H, 1009 S. Wood St. Water from these wells will serve as a baseline; After review of the data, U.S. EPA will make a decision about the on-going residential monitoring program. Revise the plan to indicate this. As previously agreed, the validated results shall be submitted to U.S. EPA for distribution. U.S. EPA also requires that Respondents request preliminary results be reported from the lab on an expedited basis. If an unexpected or adverse result is noted, then the validation of that sample result and reporting to U.S. EPA shall also be expedited so that U.S. EPA can make a decision regarding the result.

**The text has been revised based on U.S. EPA's comment. Nine residential wells have been identified along Reder Road, as well as the six residential wells listed above by U.S. EPA. Samples will be collected from these 15 residences as soon as access can be arranged with the individual homeowners or residents. The 15 residence are:**

1000	Reder Road	739	Arbogast
1007	Reder Road	1008	Arbogast
1009	Reder Road	1014	Arbogast
1029	Reder Road	1026	Arbogast
1033	Reder Road	430	Avenue H
1043	Reder Road	1009	Wood Street
1044	Reder Road		
1046	Reder Road		
1048	Reder Road		

28. **Appendix L, Private Well Database Information for the Southern Vicinity of the ACS NPL Site.**

Clarify how groundwater wells and private water supply wells are delineated. On the database for groundwater

wells, discuss what is meant by the letter designated by H under intended well use.

**Appendix L contains information from the RI Report (Private Water Supply Wells) and information obtained from the IDNR (Groundwater Wells) regarding private groundwater wells in the vicinity of the ACS facility. All the wells listed are private groundwater supply wells that are used for various purposes. The legend for the intended well use is now included in Appendix L.**

**29. Appendix L, Private Well Database Information for the Southern Vicinity of the ACS NPL Site.**

The database was to address all wells within a 2-mile radius. Discuss why the Appendix is labeled: Private Well Database Information for the Southern Vicinity of the ACS NPL Site. Provide also a diagram which overlays the groundwater contamination map on Figure 8.

**Appendix L has been re-titled: Private Well Database Information for ACS Vicinity. The approximate known extent of the upper aquifer groundwater plume has been added to Figure 8.**

**30. Figure 8, Well Search Map for ACS NPL Site.** The ACS Superfund Site does not appear to be located on the map. Please include the site on the map.

**The approximate outline of the ACS NPL Site has been added to Figure 8**

**31. Figure 8, Well Search Map for ACS NPL Site, and the Table 11, Field Identified Wells.** Discuss what is meant by field identified well.

**A Montgomery Watson professional went door to door along Colfax, Arbogast, Avenue H, and Reder Road to talk to the resident in each house. Several wells that had not been indicated by the well log search, were thereby identified in the field. These are referred to as "field identified" wells. A footnote has been added to Figure 8 to clarify.**

**32. Appendix L, Private Well Database Information for the Southern Vicinity of the ACS NPL Site.**

Several typos have been noted upon spot-checking. To the best of your ability, please assure that all information in the tables is correct. Discuss whether the well was indicated in the Remedial Investigation report and cross-reference any of those wells. Update the information in

the database if it appears that the database is outdated based upon field observation especially those wells within 1/4 mile of ACS. Indicate which wells are the ACS production well. Clarify why several wells have the same map ID location (such as #76). Finally, discuss the well usage information was derived and comment on the reliability of this data.

**The available well logs for the 1.5 mile radius of the ACS site were included in Appendix L of the RI Report. Since 1990, Indiana Department of Natural Resources (DNR) has computerized their database of well construction information. DNR developed the database by collecting as many well logs as possible from local well drillers. Some of the well logs submitted to DNR represented more than one well drilled in a general area. In this case, a single number or letter represents multiple wells.**

**A copy of the DNR database was obtained for this update and is included as Appendix L. This database alone was incomplete and was therefore unreliable. For example, although we have identified six water wells inside the ACS fence and one water well at the Kapica-Pazmey building, only two well logs were on file at DNR.**

**For this reason, a Montgomery Watson professional reviewed area maps and aerial photographs to identify residential locations, and went door-to-door along Colfax Avenue, Arbogast Avenue, Reder Road, Avenue H and Wood Street, asking residents if they had private wells on their property. The quality of the data listed on individual well logs and therefore included in the DNR database is highly variable. The quality of information is influenced by the age of the well and the driller that installed the well. Montgomery Watson has updated the information in the database to the degree possible on the basis of field observation.**

**33. Table 14, Proposed Lower Aquifer Monitoring Program.**


Include the newly installed well at the MW-10 location, (i.e., MW-50), discussed in Section 7.2.1, in the 4th quarter monitoring plan sampling.

**Monitoring well MW-51 (not MW-50) was installed as a replacement for monitoring well MW-10. A discussion of this installation has been added to Section 7.2.1. It is also included as well number 4 in Table 14.**

The Lower Aquifer Technical Memorandum has been modified in accordance with the March 3, 1997 comments as described above. The original copies of the Lower Aquifer Technical Memorandum were provided in three-ring binders. Please find attached replacement pages for each of the copies of the Technical Memorandum previously provided to you.

Sincerely,

MONTGOMERY WATSON

  
For Joseph D. Adams Jr., P.E.  
Project Coordinator

cc: H. Grejda, IDEM  
S. Mrkvika, B&VWS  
ACS Technical Committee

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**MONTGOMERY WATSON**

March 28, 1997

Ms. Sheri Bianchin, RPM  
Mail Code SR-J6  
U.S. EPA, Region V  
77 West Jackson Blvd.  
Chicago, IL 60604-3590

Re: Transmittal  
Revised Lower Aquifer Investigation Report  
American Chemical Service NPL Site

Dear Ms. Bianchin:

We have revised the Lower Aquifer Investigation Report Technical Memorandum in accordance with the U.S. EPA review comments dated March 3, 1997. We received the mailed copy of the comments on March 10, 1997. The revised Technical Memorandum is being submitted within the 21 day response period, by March 31, 1997.

The previous copies of the Technical Memorandum were provided in three-ring binders to facilitate the revision process. The following items are attached to update the reports previously submitted to the U.S. EPA.

- Five Replacement Covers
- Five copies of Technical Memorandum Text, including the Executive Summary and the Table of Contents
- Five copies each of Tables 11 and 14
- Five copies of Figure 8
- Five Copies of Revised Cover Page to Appendix L
- Five copies of Appendix O and Appendix P
- Five copies of the Montgomery Watson's Response to Comments cover letter
- One copy of the redlined text, with cross references to each U.S. EPA comment in the left margin

Please call if I can provide additional copies or further information regarding this submittal.

Sincerely,

MONTGOMERY WATSON INC.

Joseph D. Adams Jr., P.E.,  
Project Coordinator

cc: H. Grejda, IDEM (2 copies of enclosures)  
S. Mrkvika, B&V (2 copies of enclosures)  
ACS Technical Committee (1 copy each of enclosures)

## EXECUTIVE SUMMARY

This Technical Memorandum has been prepared to summarize the investigation activities and results of the Lower Aquifer Investigation conducted at the American Chemical Service, Inc. NPL site in Griffith, Indiana during January, February, and March, 1996. The primary objectives of the investigation were to characterize the hydrogeology of the lower aquifer, define the site stratigraphy, determine the horizontal and vertical gradients, identify dense, non-aqueous phase liquids (DNAPLs) if present in the lower aquifer, and to determine the horizontal and vertical extent of lower aquifer contamination. Documentation of private wells within the vicinity of the ACS facility (e.g. 2-mile radius) was an objective added during the investigation. Results from the Lower Aquifer Investigation augment lower aquifer data presented in the June 1991 Remedial Investigation (RI) report.

Investigation activities were conducted in accordance with the Lower Aquifer Investigation SOW and SOPs, approved with modifications by the U.S. EPA on January 25, 1996. Continuous core sampling and vertical profiling across the lower aquifer were conducted at four locations using rotosonic drilling methods. Vertical profile samples were collected at ten-foot intervals from the top to the bottom of the lower aquifer and analyzed for target VOCs with an on-site field gas chromatograph (GC). Following completion of coring and vertical profiling, nine monitoring wells and three piezometers were installed in the lower aquifer at six locations. The wells were subsequently developed and sampled for VOCs, semi-volatile compounds, PCBs, and inorganic parameters (total and dissolved). Continuous and "snapshot" water levels were measured in lower aquifer wells and piezometers.

Other investigation activities completed for the Lower Aquifer Investigation included evaluation and sampling of ACS production wells and identification of private wells located in the vicinity of the upper aquifer groundwater contamination detected during the Upper Aquifer Investigation.

The results of the Lower Aquifer Investigation indicate that the stratigraphy of unconsolidated deposits at the ACS site consists of an upper and lower sand aquifer separated by a clay confining layer. The thickness of the upper clay confining layer varies from 2.5 feet to 35 feet. Underlying the upper confining layer, the lower aquifer consists of well sorted gray to brown fine sand which varies in thickness between 40 to 68 feet. Below the lower aquifer is the lower clay confining layer. It is about 12 to 20 feet thick and overlies dark gray shale bedrock.

Water levels measured on March 15, 1996 at the lower aquifer wells and piezometers indicate that the vertical gradients are relatively low and variable. Values ranged from 0.0007 upward at one location, to 0.005 downward at another location. At the five locations where gradients were calculated, the overall gradient from the top to bottom of the lower aquifer was downward at three locations, upward at one location, and there was no overall vertical gradient at the fifth location. The horizontal gradient in the lower aquifer measured on March 15, 1996 was northward with a value of 0.00047. The direction of the gradient

was consistent with previous measurements and the value of 0.00047 was consistent with the findings from the October 30, 1995 measurements.

The bottom of the zone of contamination in the lower aquifer in the vicinity of existing monitoring well MW9 was successfully confirmed by the placement of MW29 during this investigation. Therefore no further investigation or monitoring well installations are recommended at this location. However these points will be included in the monitoring program.

Although potential VOC contaminants were indicated by the field GC analysis of two samples from vertical profile VP3 (the well nest containing MW8, MW31, and MW32), subsequent sampling of MW31 and MW32 did not confirm the detections. VOC concentrations were found in lower aquifer water samples collected from two ACS production wells (IW1 and IW4). Acetone and 2-butanone were detected in IW1 at 14 µg/L and 11 µg/L, respectively and xylene was detected in IW4 at 13 µg/L. Estimated concentrations of several VOCs were found in water samples collected at both wells at individual concentrations less than the detection limit of 10 µg/L.

Several of the lower aquifer monitoring well samples contained phthalates at concentrations between the detection level and 100 µg/l. A common source for low levels of phthalates is laboratory contamination. However, since phthalates are included in the list of compounds with remediation levels in the Site ROD, the occurrences will be further evaluated during the monitoring program. Except for the phthalate anomaly and detections of manganese and thallium at MW33, there were no exceedances of remediation levels in samples collected at the downgradient site boundary (north side of the site) in the lower aquifer. PID readings during the field investigation indicated the potential for contamination in the upper few feet of the lower aquifer at monitoring well location MW10. However, no monitoring well was installed at this location, since monitoring well MW10 was already screened 10 to 15 feet below the clay confining layer that marks the top of the lower aquifer. A new monitoring well with a ten-foot screen will be installed, extending from just below the confining clay from elevation 613 feet above mean sea level to 603 feet above mean sea level. This new well will replace existing monitoring well MW10 in the ongoing monitoring plan.

A zone of upper aquifer contamination was better delineated during the Upper Aquifer Investigation. Chloroethane and benzene were detected at levels below remediation levels and MCLs at private well PW02, which appears to be drilled through the zone of upper aquifer contamination. An additional lower aquifer well will be installed downgradient of the PW02 location to evaluate the lower aquifer in this area. The monitoring wells are scheduled for installation in mid-October 1996. It has been assumed that these two new wells will be included in the sampling planned for the end of October 1996

The nature of the contamination in the lower aquifer at the Site has been defined to date by the compounds detected at monitoring well MW9, the trace levels of PCE and xylenes in the samples from ACS production wells IW1 and IW4, and from the oily sheen observed in the water in production well IW6. Production wells IW5 and IW6 may provide a route for

contaminants to move from the upper aquifer to the lower aquifer. Given the high levels of contamination inside the ACS Site and the strong downward gradients from the upper to lower aquifers, decisions regarding the placement of additional lower aquifer wells within the Site boundaries will be deferred until after the upper aquifer groundwater treatment system is operational. At that time, the highly contaminated areas may be dewatered and the strong downward gradient will be eliminated.

The two abandoned and the four currently used ACS production wells will be further investigated by sounding and geophysical logging. They will be sampled for TCL/TAL parameters and then permanently abandoned by sealing with grout. A sample of the material with the oily sheen in well IW6 will be collected and analyzed for TCL parameters. A plan for the ongoing monitoring of the lower aquifer is presented as part of this document.

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## INTRODUCTION

This Technical Memorandum summarizes the investigation activities and results of the Lower Aquifer Investigation conducted at the American Chemical Service, Inc. NPL site in Griffith, Indiana during January, February, and March 1996. The investigation was conducted in accordance with the Lower Aquifer Investigation SOW and SOPs, approved with modifications, by the U.S. EPA on January 25, 1996. Results from the Lower Aquifer Investigation augment the lower aquifer data presented in the June 1991 Remedial Investigation Report (RI).

### 1.1 OBJECTIVES

The objectives of the Lower Aquifer Investigation were to:

1. Determine the stratigraphy of the lower aquifer.
2. Determine the horizontal and vertical extent of lower aquifer groundwater contamination.
3. Determine if contaminants have reached the downgradient point of compliance from the Site and if so, determine their vertical concentration profile in the lower aquifer.
4. Determine the horizontal and vertical gradients in the lower aquifer.
5. Determine if dense, non-aqueous phase liquids (DNAPLs) are present in the lower aquifer.
6. Identify the residential drinking water wells within a two-mile radius of the site.

## 1.2 SCOPE OF WORK

The following activities were completed to meet the objectives of the Lower Aquifer Investigation:

- Continuous core samples of the lower aquifer matrix material were collected to the base of the lower aquifer at four locations using a rotosonic drilling method.
- Vertical profiling was conducted across the lower aquifer at four locations. Groundwater samples were collected at ten-foot intervals from the top to the bottom of the lower aquifer and analyzed for target VOCs with the on-site field gas chromatograph (GC).
- Eight monitoring wells and three piezometers were installed in the lower aquifer at six locations.
- Water levels were measured in lower aquifer wells and piezometers.
- The four current ACS production wells were sampled for VOCs.
- Chemical time-series samples were collected at ACS production well IW1 and analyzed with the field GC.
- The two abandoned ACS production wells were inspected.
- Water levels were measured and recorded in two monitoring wells and one piezometer continuously for approximately 30 days.
- Private wells located within a two-mile radius of the ACS facility were reviewed to identify potential private drinking water sources .

## Field Activities

### 2.1 DRILLING

#### 2.1.1 Setting Casing

Surface casing was initially installed at all boring locations to prevent potential downward migration of upper aquifer contaminants to the confined lower aquifer. The eight-inch diameter casings were set, using a hollow stem auger drilling rig. The casings were set a minimum of 12 inches into the clay confining layer found between the upper and lower alluvial aquifers. The casings were sealed in place with cement bentonite grout.

#### 2.1.2 Continuous Coring

Borings into the lower aquifer were conducted at six well locations surrounding the ACS facility: MW9, MW10, MW8, MW7, MW28, and M4 (Figure 1). At the first boring at each of the six locations, continuous core samples were collected with roto-sonic drilling methods, starting at the base of the surface casing and continuing to the base of the lower aquifer. Cores were collected in ten foot lengths, extruded into core sleeves and stored in boxes staged on site. The cores were evaluated, logged, photographed, and screened for the presence of VOCs in the aquifer matrix using the PID headspace method. Table 1 identifies the number and location of continuous cores collected during the Lower Aquifer Investigation.

Drilling was conducted in accordance with the approved Sonic Drilling Sampling Protocol SOP for the Lower Aquifer Investigation (revision: January 25, 1996) with the following exception:

- Borings were extended to bedrock at the PZ43 (MW17) and MW10 (VP02) locations to determine the thickness of the lower clay and characterize the bedrock.

Boring logs for lower aquifer wells and piezometers are included in Appendix A.

### 2.1.3 Vertical Profiling

The objective of determining the presence of DNAPLs and screening for the vertical and horizontal extent of VOCs in the lower aquifer was accomplished by vertical profiling at four downgradient locations. Vertical profile samples, labeled with a VP designation, were collected at MW9 (VP1), MW10 (VP2), MW8 (VP3) and M4 (VP4) (Table 1). Continuous cores of aquifer material were brought to the surface during the drilling and each core was examined inch by inch, for any sign of NAPLs and to document the geologic material and strata. The locations of the vertical profile samples are shown on Figure 1.

After each ten-foot core run was extracted from the borehole, a power punch was inserted into the zone that was just cored. The water-tight power punch casing was subsequently retracted to expose a four-foot long, 1.75-inch diameter screen. Groundwater was then purged and sampled using a Grundfos submersible pump, which was set two feet above the filter pack applied to the power punch well screen. The flow rate during purging was approximately 300 milliliters/minute and it was decreased to 200 milliliters/minute during sample collection. The amount of groundwater purged and flow rate used to purge is presented in Appendix B. While water is used in the roto-sonic drilling method, there were no significant losses of drilling water, because the drilling was conducted in a saturated sand formation.

Vertical profiling was conducted in accordance with the approved Sonic Drilling Sampling Protocol SOP for the Lower Aquifer Investigation (revision: January 25, 1996) with the following exceptions:

- Fine sandy soils were encountered during the vertical profiling activities. These sands often caused the screen of the power punch to become clogged. To address this difficulty, with concurrence from the U.S. EPA, filter pack sand was placed inside the power punch screen prior to installation to prevent sand from flowing into the power punch.
- The power punch was typically installed near the top of the cored interval rather than the center (i.e., if the core run was 25 to 35 feet, the power punch was installed from 25 to 29 feet). The modification was necessary because of the drilling platform heights and lengths of drill strings.

Vertical profiling purging and sampling information is presented in Appendix B.

### 2.1.4 Field GC

Groundwater samples from the vertical profiling were screened for target VOCs using a field GC. The target VOC list included the following compounds: acetone, 1,1-dichloroethene (1,1-DCE), cis- and trans-1,2-dichloroethene, methyl ethyl ketone, 1,2-dichloroethane (1,2-DCA), 1,1,1-trichloroethane (1,1,1-TCA), benzene, carbon tetrachloride, trichloroethene (TCE), methyl isobutyl ketone (MIBK), 1,1,2-trichloroethane, toluene, tetrachloroethene (PCE), chlorobenzene, ethylbenzene, m+p xylene, styrene and o-xylene.

All field GC analyses were performed in accordance with the approved SOP for the Lower Aquifer Investigation (Field GC - Purgeable Volatiles Analysis Protocol, revision: January 25, 1996).

## **2.2 WELLS AND PIEZOMETERS**

### **2.2.1 Installation**

Following completion of continuous coring at vertical profile locations, a monitoring well or piezometer was installed at the base of the aquifer. At each location, a second monitoring well or piezometer was then set at the approximate midpoint of the lower aquifer in a second borehole, which was not cored. At MW7 and MW28, where vertical profiling was not conducted, the first boring was cored to the base of the aquifer and a well or piezometer was screened at the base of the lower aquifer. A second boring was then installed at the approximate midpoint of the lower aquifer.

With the exception of location M4, where a thicker clay confining layer was encountered, each lower aquifer drilling location presently contains three screened devices (monitoring wells or piezometers), one near the base of the lower aquifer, one at the approximate midpoint of the lower aquifer, and one at the top of the lower aquifer. A summary of monitoring well and piezometer installation activities is presented in Table 1. Monitoring well and piezometer coordinates, ground and top-of-casing elevations, and construction details are presented in Table 2.

Well and piezometer installation was conducted in accordance with the approved Sonic Drilling Sampling Protocol SOP for the Lower Aquifer Investigation (revision: January 25, 1996) with the following exceptions:

- Because VOCs were detected at the base of the lower aquifer at MW8, with U.S. EPA concurrence, the deep PVC piezometer scheduled for installation at the base of the lower aquifer was replaced with a two-inch diameter stainless steel monitoring well with a ten-foot screen. The planned piezometers were replaced by monitoring wells in the lower zone at MW7, MW8, MW9, MW10 and M4 locations following U.S. EPA approval.
- Because the lower aquifer was thinner than estimated in the work plan (the bottom of the lower aquifer was encountered at an elevation of approximately 540 feet above mean sea level (amsl) rather than 510 feet amsl estimated in the Work Plan), wells or piezometers installed in the middle zone were not screened at the 550 foot amsl elevation. Screen elevations for wells and piezometers are shown on Table 2. Vertical placement of the wells or piezometers in the middle zone of the lower aquifer was based on placement criteria stated in the Lower Aquifer Investigation SOW. This criteria indicated that wells or piezometers would be installed either at a depth exhibiting the highest concentrations of contamination detected by the vertical profiling, or, if no contamination was found, the well or

piezometer would be installed at a depth representative of the middle zone of the aquifer.

- At the M4 location, the upper confining layer was significantly thicker than observed elsewhere at the ACS site and the lower aquifer correspondingly thinner. The thickness of the lower aquifer at this location was approximately 40 feet. Because of the reduced thickness of the lower aquifer, only two screened devices are presently installed at the M4 location; monitoring well MW35 at the base of the lower aquifer, and existing well M4 screened at the top of the aquifer. The elevation of the upper zone at existing well M4 is laterally equivalent in elevation to the other middle zone wells installed during the lower aquifer investigation. Surface casing which was installed at M4 for placement of the middle zone well was left intact and sealed at the ground surface. The U.S. EPA oversight contractor was informed of the field judgment call not to install the third piezometer vertically between M4 and MW35. It is recognized that a middle zone well or piezometer could be installed at this location at a later date, if necessary, using the existing surface casing.
- Item number VI.B.6.c. of Installation of Wells and Piezometers in the SOP contains an error. The SOP states that six inches of fine sand should be placed above the bentonite seal. Actually, the fine sand is intended to prevent intrusion of the bentonite seal into the filter pack. Therefore, the fine sand was placed between the filter pack material and the bentonite seal. This field modification was made at all wells with the concurrence of the U.S. EPA oversight contractor.
- The protective covers were not set in a bed of sand. This was not done because the base of the protective covers were placed inside permanent casings installed as part of the surface casing installation activities. The permanent casings would not allow for drainage of water to occur that may have accumulated inside the protective cover. Weep holes were subsequently drilled into the stick-up well protectors to allow drainage of water.
- Brass locks were installed on all new wells and piezometers. Therefore, the locks did not require lubrication as stated in the SOP.

Well construction forms for lower aquifer wells and piezometers are included in Appendix C.

### **2.2.2 Development**

Following installation of monitoring wells and piezometers in the lower aquifer, the wells and piezometers were surveyed and developed. Development was conducted in accordance with the approved March 1996 Well Development SOP for the Lower Aquifer Investigation with the following exceptions:

- Monitoring wells MW31, MW32, and MW33 were each surged for ten minutes using a bailer rather than the 20 to 30 minutes indicated in the SOP. After development of all wells except MW31, MW32, and MW33, it was apparent that using the submersible pump to surge the wells during development was more effective in removing sediment from the filter pack than the bailer. Additionally, by using the pump to surge the well, specific zones within the well screen were incrementally developed by slowly raising and lowering the pump through the screened interval during purging. This field modification was made with the concurrence of the U.S. EPA oversight contractor.
- The submersible pump was not allowed to rest stationary at the well bottom. If the pump motor was positioned at the base of the pump (and not the intake), resting the pump at the bottom of the well would not let water flow around the motor and could potentially cause the pump to overheat. Additionally, the use of the pump to surge the well did not allow the pump to remain stationary at the bottom of the well.
- The relative recovery of the wells was not measured following development. This was not done because the pump was not equipped with a check valve to prevent backflow of water contained in the pump hosing from flowing back into the well. Therefore, as soon as the pump was turned off, the water contained within the pump hosing would flow back into the well and cause the water level in the well to become artificially recharged. Measurement of recharge would then be biased by the volume of water contained within the hose.

Well development forms are included as Appendix D.

## 2.3 WATER LEVELS

### 2.3.1 Continuous Measurements

To further evaluate the hydraulic characteristics in the lower aquifer, continuous water level readings were monitored with transducers and data loggers at MW7, MW9, and P-8 for a period of approximately 30 days during the lower aquifer investigation. The continuous monitoring was conducted to provide an extended record of variability of water levels in the upper and lower aquifers at the site.

Continuous monitoring activities were performed in accordance with the approved SOP for the Lower Aquifer Investigation (Groundwater Level Monitoring using Two-Channel Hermit Data Logger, April 1993) contained in the January 25, 1996 Lower Aquifer Investigation SOW and SOP. The data loggers were checked and downloaded every five to seven days to ensure they were functioning and recording representative data.

### **2.3.2 Snapshot Gauging Event**

To determine horizontal and vertical gradients in the lower aquifer, water level measurements were made at new and existing lower aquifer wells and piezometers on March 15, 1996. Lower aquifer wells at the City of Griffith landfill (M1 through M5) were not measured because access could not be obtained from the landfill's consultant during the time frame requested.

## **2.4 ACS PRODUCTION WELLS**

### **2.4.1 Current Wells**

Four existing and two abandoned production wells were identified at the ACS facility in the Lower Aquifer SOP. Wells IW1 through IW4 are active wells which are currently used by ACS. The wells consist of four inch diameter casing which were formerly operated on a daily basis. The four active wells were sampled during the lower aquifer investigation and samples were analyzed by the laboratory for TCL VOCs. The four active production wells are integrally connected to the water supply system and are sealed at the surface, therefore water level information could not be collected. Sampling was conducted in accordance with the approved SOP, Active Production Well Evaluation and Sampling, for the Lower Aquifer Investigation (revision: January 25, 1996).

### **2.4.2 Abandoned Wells**

The abandoned production wells IW5 and IW6 were inspected and field evaluated to determine:

- The surrounding casing and physical condition of the casing
- The total well depth and the depth to water
- The presence of any non-aqueous phase liquid in the well
- The feasibility of reclosing the well

Evaluation of the abandoned ACS production wells was conducted in accordance with the approved SOP, Abandoned Production Well Evaluation for the Lower Aquifer Investigation (revision: January 25, 1996).

### **2.4.3 Time-Series Sampling**

On February 23, 1996, a series of water samples was collected from production well, IW1, during continuous pumping. The objective of the time-series sampling was to document variability in the concentrations of VOCs in IW1 (see Section 5.2) behaved in response to the continuous withdrawal of water from the well. Sampling was conducted in accordance with the approved SOP, Active Production Well Evaluation and Sampling for the Lower Aquifer Investigation (revision: January 25, 1996). Because the well was operated continuously over the eight hour period of sampling, it was assumed that the running water was representative of new formation water. Therefore, temperature measurements were not collected during sampling.



## **2.5 MONITORING WELL SAMPLING**

To determine the horizontal and vertical extent of contamination in the lower aquifer and confirm the results of the vertical profiling, new lower aquifer monitoring wells at the site were sampled on March 12 to 14, 1996 for VOCs, semi-volatile compounds, PCBs and metals (total and dissolved). Sampling was conducted in accordance with the approved March 1996 Groundwater Monitoring Well Sampling SOP for the Lower Aquifer Investigation with the following exception:

- For dissolved metals analysis, the samples were not filtered using an in-line filtering device connected to the discharge line of the sampling pump. The inside diameter of the line was too large to provide a sufficient seal to allow water to pass through the filter. Therefore, filtering was conducted by filling a one-liter polyethylene container with the water sample and using a peristaltic pump with an attached 0.45 micron in-line filter to pump water through the filter. The sample was filtered immediately (within ten minutes) following collection.

Monitoring well sampling forms are included as Appendix E.

## **2.6 PRIVATE WELL IDENTIFICATION**

Although not included in the Scope of Work for the Lower Aquifer Investigation, a private well identification process was initiated in the vicinity (e.g. 2-mile radius) of the ACS site because of findings in the Upper Aquifer Investigation. The well search was intended to build on the well location data presented in the RI report and the Upper Aquifer Technical Memorandum. During the field investigation, the water well identification program was focused on homes and businesses located along South Colfax Avenue and Main Street in the vicinity of ACS, and along Reder Road, Arbogast Avenue, and Avenue H. Since the field investigation, the newest data base of water wells was obtained from the Indiana Department of Natural Resources for the communities in a two-mile radius of the site. This new data base, along with the wells identified during the field investigation have been used to supplement the water well data base developed during the RI.

## HYDROGEOLOGY OF THE LOWER AQUIFER

### 3.1 GEOLOGY

The geology and stratigraphy of the unconsolidated aquifers and confining layers was developed from a detailed inspection of the continuous cores, and grain size tests from discrete intervals in each of the six boring locations. Boring logs for existing well locations (MW9, MW10, MW8, MW7, MW28, and M4) are presented in Appendix A1; boring logs generated during the Lower Aquifer Investigation are included in Appendices A2 through A7. Stratigraphic depths, elevations and thickness of geologic units encountered at the site are summarized in Table 3. A location map of cross sections through the site is presented in Figure 2. Figure 3 shows the western cross section through the monitoring well locations PZ43, MW35, MW34, and MW33; Figure 4 presents the central cross section through PZ43, MW36, and MW8, and Figure 4A presents a cross section through the western most available boring locations. Grain size distribution test results are presented in Table 4 and grain size reports are included in Appendix F.

As shown by the cross sections, the unconsolidated stratigraphy of the ACS site is generally uniform and consists of an upper and lower sand aquifer separated by a clay confining layer. Another clay confining layer was identified between the lower aquifer and the bedrock (Figures 3, 4, and 4A). Each of these hydrogeologic units is described below.

#### 3.1.1 Upper Aquifer

Based on geotechnical results presented during the March 1996 Barrier Wall Alignment Investigation Report, soils of the upper aquifer are generally classified as a fine to coarse sand with a trace to some silt and clay. The soils encountered were classified with the Unified Soil Classification System (USCS) symbols of SP, SP-SM, and SM. The thickness of the upper aquifer encountered during this investigation ranged from approximately 27.5 feet at MW28 southeast of the site to 13.5 feet at MW33 to the northwest (Table 3). At MW35, the upper aquifer was only 13 feet thick, which may be due to excavation activities at the Griffith landfill. More data on the geology and thickness of the upper aquifer is presented in the June 1991 Remedial Investigation (RI) Report and in the October 1996 Upper Aquifer Technical Memorandum.

### 3.1.2 Upper Clay Confining Layer

From the RI investigation, it was evident that the upper clay confining layer was greater than 20 feet thick to the south of the site and less than five feet thick at the northern side of the Site (2.5 and 4.0 feet at CB-1 and MW33, respectively).

However, even after making three boreholes to install MW10C during the RI, uncertainty remained regarding the thickness of the confining clay layer in an area 300 feet northwest of the ACS facility (Figure 2). Three boreholes were made in March and April 1990 to place a well at the MW10C location. The drillers experienced difficulty in maintaining an open hole and collecting representative samples. An additional soil boring, CB-1, was advanced to determine the clay thickness in the vicinity of MW 10C. The thickness of clay in CB-1 appeared to be approximately 2.5 ft. The boring logs for MW10A, MW10B, MW10C, and CB-1 are included in Appendix A1, and these show the uncertainty in the thickness of the clay layer that remained after the RI. Approximately 3.5 feet of lean clay was indicated between a depth of 15.5 and 19 feet at boring MW10A. Approximately four feet of silty and sandy clay were indicated between a depth of 17 and 21 feet at MW10B. Approximately four feet of clay and silty clay were indicated at a depth of 16 feet in the borehole for MW10C.

During the RI, to evaluate the potential that this location might represent a discontinuity in the clay confining layer, a monitoring well was placed at borehole MW10C (Figure 2). Although the logs indicate thin clay layers that are silty and sandy, the hydraulic data has indicated that a low permeability layer does exist. The water levels in monitoring well have been consistently similar to the lower aquifer rather than the upper aquifer levels. The water level elevation at MW10C at the October 30, 1995 water level measurement was 619.77 feet amsl. The water table elevation in the upper aquifer in the vicinity of MW10C was 629.15, as indicated by piezometer P-25. These water levels indicate that the strong downward gradient that exists elsewhere on site, where the clay confining layer has been confirmed to exist, also is found at location MW10C.

Borings made during the RI and the Dewatering/Barrier Wall Investigation show that the upper surface of the clay confining layer is generally encountered within 2 feet of 620 feet amsl. During this investigation the upper clay confining layer was observed between 617 feet amsl (VP03 location) and 621 feet amsl (MW28 and VP02 location). During the RI investigation the upper clay confining layer was observed at an elevation of 614 feet amsl in MW22. The highest elevation of the upper clay confining layer was observed at MW18, at an elevation of 625 feet amsl. The clay confining layer is generally classified as clay with a USCS symbol of CL. The thickness of the confining unit documented during the lower aquifer investigation was consistent with the findings in the RI. It appears to thin from the south to northwest (Figure 3). At the southern portion of the site at MW35 and PZ43, the clay is 35 feet thick and 31 feet thick, respectively. At the northern side of the site, at MW33, the clay thickness is four feet thick.

According to the rigid-wall falling head permeability testing performed for the Barrier Wall Alignment Report (U.S. Army Corps of Engineers Method EM 1110-2-1906 (VII)), the

permeability of the upper clay confining layer ranged from  $1.7 \times 10^{-8}$  cm/s (centimeters per second) to  $2.4 \times 10^{-8}$  cm/s based on relatively undisturbed Shelby tube samples collected during the Dewatering/Barrier Wall Investigation early in 1996. (These results are similar to the results obtained in the RI.) Liquid and plasticity limits ranged from 28 to 30% and 11 to 14%, respectively.

### **3.1.3 Lower Aquifer**

The top of the lower aquifer was encountered at elevations ranging from 614 feet amsl at MW33 located northwest of the ACS facility to 584 feet amsl at MW35 (Figure 3; Table 3). Where the upper clay layer was thinner (MW33), the top of the lower aquifer was found at higher elevations.

The geology of the lower aquifer is a well sorted gray to brown, dense, fine sand, with a trace of silt and clay (Appendix A). Grain size analyses of grab samples taken from various depths during rotosonic drilling indicates the general uniformity of the lower aquifer, with most sand fractions accounting for more than 90 percent of the total grain size fraction (Table 3). The soils encountered were classified with the USCS classification symbols of SP, SP-SM, and SM. No varves or bedding planes were evident in any of the continuous cores. In general, the rotosonic drilling appeared to provide relatively undisturbed cores of the unconsolidated lower aquifer material.

Some intervals within the lower aquifer contain occasional zones with more gravel or silt and clay fractions. At PZ43, basal sand and gravel was found at a depth of 96 to 98 feet immediately overlying the lower clay confining unit (Appendix A). At MW35, the lower aquifer contains more gravel at a depth of 48 to 55 feet (32% gravel at 55 feet; Table 4) and is siltier from 82 to 88 feet (14% silt and clay at 85 feet; Table 4). At MW31 and MW32, fine to coarse sand was encountered from 64 to 78 feet, and a cobble was found at 69 feet (Appendix A). Grain size analysis of a grab sample at 70 feet from MW31 indicated a gravel percentage of 13% (Table 4).

Based on borings made through the lower aquifer, the basal surface of the lower aquifer is relatively flat and ranges between 540 and 550 feet amsl (Table 3). The thickness of the lower aquifer varies between approximately 40 feet to the south (MW35 and PZ43), and 65 feet to the north and northwest (MW32 and MW33).

### **3.1.4 Lower Confining Layer**

A lower clay confining unit underlies the sands of the lower aquifer at elevations between 540 feet to 550 feet amsl (Table 3). This lower confining unit consists of predominantly stiff, gray, lean silty clay with a trace of fine sand and gravel (Appendix A). The thickness of the lower confining unit was penetrated at the PZ43 and MW33 locations. At these locations, the clay unit was 12.5 feet and 20 feet thick, respectively.

### **3.1.5 Bedrock**

Dark gray shale was the uppermost bedrock unit encountered at the site. Shale was found at PZ43 and MW33 locations at elevations of 538 feet and 527 feet amsl, respectively. No other borings were extended through the lower clay during the Lower Aquifer Investigation.

## **3.2 WATER LEVEL MEASUREMENTS**

Water level measurements were made at new and existing lower aquifer wells on March 15, 1996. Lower aquifer wells at the City of Griffith landfill (M1 through M5) were not measured because access could not be obtained from the landfill's consultant in the time frame available. The measured water level depths and calculated groundwater elevations are tabulated in Table 5. Depth to water in the lower aquifer ranged between 11.16 feet at MW23 to 25.80 feet at MW28 (Table 5).

The average water level elevation in the lower aquifer was approximately 622 feet amsl. Water levels in the upper aquifer averaged approximately 630 feet amsl as reported in the Upper Aquifer Investigation Technical Memorandum

## **3.3 VERTICAL GRADIENTS**

Table 6 presents vertical hydraulic gradients measured between nested wells installed in the lower aquifer. Vertical gradients were calculated by dividing the difference in head between nested wells by the distance between the screen midpoints for the wells. Because access could not be obtained at M4, the vertical gradients between M4 and MW35 could not be determined.

Vertical gradients between grouped wells ranged from 0.0007 upward in the middle zone at MW8 and MW10 locations, to -0.005 (downward) between MW10 and MW30 installed in the upper and middle zones of the lower aquifer (Table 6). The greatest difference in groundwater elevation between nested wells was -0.11 feet at MW10 and MW30. Because of the head difference observed between MW10 and MW30, the continuous core collected at this location (MW33 core) was reexamined. A slight coarsening in sand grain size was observed between the upper portion of the lower aquifer screened by MW10 and the middle portion of the lower aquifer screened by MW30. No evidence of silt or clay layers was found in the core at this depth.

Other lower aquifer well nests exhibited head differences less than 0.10 feet (Table 6). The final column on Table 6 shows the calculated vertical gradient from the top to the bottom of the lower aquifer. Well nests, MW8/MW32, MW9/MW34, and MW28/PZ43, did not exhibit any vertical gradients between wells installed at the top of the lower aquifer to wells installed at the bottom of the aquifer. Although the vertical gradients appear to be an order

of magnitude higher than horizontal gradients, the gradients are calculated from very small difference in head, across much shorter distances than the horizontal gradients.

Both the horizontal gradients and the vertical gradients are calculated by dividing the difference in water level by the distance between the points of measurement. In both cases the water levels were measured in wells (or piezometers) located in generally the same vicinity, but screened at different depths. In the case of the horizontal gradients, the distance between the two measurements was the horizontal distance between the two wells. In the case of vertical gradients within the same aquifer, the distance was measured between the centers of the wells screens, and in the case of vertical gradients calculated across the clay confining layer, the distance was measured as the total thickness of the clay confining layer.

The water elevation is calculated from two measurements, each measured to the nearest 0.01 foot. The first measurement is the top of casing elevation, which is established to Site datum by survey. The second measurement is the measured depth to the water below the top of casing. If it is assumed that each of these measurements is accurate to within one-half of the smallest unit of measurement, it is evident the margin of error for any groundwater elevation calculated for the Site is 0.01 foot.

If a water level difference is measured to be 0.01, it is within the margin of potential error and therefore it must be regarded as indistinguishable from zero (0.0). This fact can be used to calculate the smallest quantifiable gradient between any two measurement points.

For example, a horizontal gradient is calculated for the lower aquifer between MW22 and MW10. The gradient is calculated by dividing the difference in groundwater elevation between the two locations, by the distance between the two wells. The result of this calculation is presented in Section 3.4 of the Lower Aquifer Technical Memorandum and indicates a horizontal gradient across the Site of 0.00047. To calculate what the lowest quantifiable horizontal gradient is, one takes the lowest quantifiable groundwater elevation difference (0.01) and divides it by the distance between the two wells. This calculation (0.01 feet / 2,850 feet) indicates that a horizontal gradient of 0.0000035 would be indistinguishable from a gradient of zero, for this setting.

The lowest quantifiable vertical gradient can similarly be calculated for each well nest location. From Table 6, we find that the well screen separation distances vary between 14 feet and 33 feet. The following tabulation shows that the lowest quantifiable vertical gradient in the lower aquifer with the existing well nests ranges between 0.0007 and 0.0003.

Potential Error	Screen Separation	Lowest Quantifiable Gradient
0.01 ft	14 ft	0.00071
0.01 ft	33 ft	0.00030

Table 6 shows the calculation of 15 vertical gradients. Nine of them are within the range between 0.0003 and 0.0007. Therefore, 60 percent of the vertical gradients are in essence, indistinguishable from zero. Nine of the calculated gradients have negative values, indicating a downward direction and five have positive values, indicating an upward direction. Given the fact that calculated gradients are both vertical and horizontal, and that a majority of calculated gradients are indistinguishable from zero. This variability of the vertical gradient data shows a lack of consistency and indicates that there is not an overall trend in the vertical gradients in the lower aquifer.

Based on the difference in groundwater elevation between the upper and lower aquifer (approximately 8 feet), there is a strong downward vertical gradient through the upper confining layer between the two aquifer systems. Using an average water level difference of 8 feet between the upper and lower aquifers, and considering the upper confining layer thickness at MW35 (35 feet thick) and MW33 (4 feet thick) to bound the range of thicknesses for the confining unit, the vertical gradients calculated between the two aquifer ranged from 0.23 to 2, respectively. This suggests that the low permeability of the upper confining layer ( $2 \times 10^{-8}$  cm/s) provides a substantial barrier to vertical groundwater flow between the two aquifers. The permeability of the upper confining layer is based on the data collected during the Dewatering/Barrier Wall investigation conducted in January and February 1996.

### 3.4 GROUNDWATER FLOW DIRECTION

Figure 5 shows the groundwater potentiometric surface in the lower aquifer. The direction of horizontal groundwater flow in the lower aquifer is generally northward. This information is based on water levels measured in lower aquifer wells installed at the top of the aquifer. These wells were utilized for groundwater flow determinations because: 1) most lower aquifer wells at the ACS site are screened at the top of the aquifer which subsequently provide more data points for the potentiometric surface contour plot; 2) water level data from the top of the lower aquifer are comparable to water level data previously collected for the lower aquifer; and 3) the lack of consistent vertical gradients in the lower aquifer suggests that horizontal flow at the top of the aquifer is the same as horizontal flow at the base of the aquifer. The northward direction of groundwater flow in the lower aquifer is consistent with lower aquifer data presented in June 1991 RI and the October 30, 1995 Technical Memorandum.

The horizontal hydraulic gradient in the lower aquifer was determined to be 0.00047, as measured from MW22 located in the southern portion of the site, to MW10 located at the northern site boundary. The gradient was determined by dividing the difference in head between the two wells (1.35 feet) by the lateral distance (2,850 feet). The resultant gradient (0.00047) is consistent with lower aquifer gradients presented in the RI report (gradient = 0.0006) and the October 30, 1995 Technical Memorandum (gradient = 0.00041). Although the vertical gradients appear to be much stronger than the horizontal gradients, this is in fact an anomaly, related to measurement error inherent in this situation where small water

level differences are measured across short distances. (See discussion in Section 3.3). The horizontal gradients in the lower aquifer are relatively low but they have been highly consistent in magnitude and direction during the investigations conducted since 1989. Vertical gradient calculations in the lower aquifer have only been possible since 1996 so the total amount of data is more limited. However the data collected to date show vertical gradients that are low (60 percent are indistinguishable from zero) and variable both in magnitude and direction (up versus down). Therefore, it is reasonable to conclude that the overall groundwater flow in the lower aquifer is horizontal although there may be local vertical components to flow.

### 3.5 CONTINUOUS WATER LEVEL MEASUREMENTS

Continuous water level measurements were recorded at three monitoring wells during the Lower Aquifer Investigation using pressure transducers and data loggers. Two wells monitored the upper and lower aquifer at one location (P8 and MW7, respectively) and one well (MW9) monitored the lower aquifer at a second location. The data collection activities are summarized below:

Well No.	Start Date	Start Time	End Date	End Time
P8	2/7/96	1610	3/5/96	1130
MW7	2/7/96	1610	3/5/96	1130
MW9	2/2/96	1000	3/5/96	1220

Due to a data logger malfunction, water level information at P8 and MW7 from February 2 to February 7, 1996 was not collected. Figure 6 shows a plot of the continuous water levels for the nested pair, P8 and MW7, and Figure 7 presents a plot of MW9. Raw data and plots of continuous water levels over consecutive ten-day periods are included in Appendix G.

The continuous water level data for all three wells show a similar pattern of fluctuations in response to environmental conditions. At the nested well pair, P8 and MW7, the upper aquifer well P8 appears to exhibit greater magnitude of fluctuation than the lower aquifer well, MW7, although the water level trends between the two aquifer systems are similar. The total variability in water levels exhibited by the three wells during the period of continuous monitoring was approximately 0.7 feet in P8, 0.95 feet in MW7, and 1.0 feet in MW9 (Figures 6 and 7).

At both lower aquifer monitoring locations (MW7 and MW9), an increase in hydraulic head is noted over the last four days of continuous monitoring (February 27 through March 2). This increasing trend is also apparent in upper aquifer piezometer P8 on February 27 and 28. A 0.95-inch rainfall event occurring on February 27 may explain the increase in hydraulic head in these wells (rainfall data provided by the City of Gary Air & Land Pollution Control Department). After February 28, the change in head in P8 stabilizes,



whereas the lower aquifer wells, MW7 and MW9, continue to increase until March 2 (Figures 6 and 7).

Barometric data for the 30 days of continuous water level measurements were obtained from the Gary, Indiana airport, located approximately eight miles north of the ACS facility. The data was plotted on the same scale as the water level data and has been included in Appendix G1. By overlaying the barometric plot on the water level plot, one may observe the similarities and differences. Several generalizations can be made:

- Water levels in the two lower aquifer wells MW7 and MW9 are very similar to each other, indicating that the lower aquifer is responding to the same stresses at both locations.
- The water levels in piezometer P8, screened in the upper aquifer, show a greater magnitude of variation than the wells in the lower aquifer, and the variability closely reflects the variability in the barometric pressure, for the first 20 days. After that, the correlation decreases.
- The lower aquifer wells, MW7 and MW9, do not show as close a correlation to the barometric pressure as the upper aquifer piezometer.
- Evidence of pumping activities is not readily apparent in either the upper aquifer water level (P8) or in the lower aquifer water levels (MW7 and MW9).
- The primary changes in the water levels in both the upper and lower aquifer usually correlate to the changes in the barometric pressure. There are no discernible systematic variations from the barometric pressure. Therefore, there is not a sound basis for identifying pump cycles.

## ANALYTICAL RESULTS

### 4.1 VERTICAL PROFILE SAMPLING RESULTS

Target VOC analytical results for vertical profile samples collected at MW9 (VP1), MW10 (VP2), MW8 (VP3), and M4 (VP4) are presented in Table 7. A total of 24 vertical profile samples were collected and analyzed with a field GC during the Lower Aquifer Investigation at the four locations. Seven samples were taken at approximate ten-foot intervals at MW9 and MW10, six samples were collected at MW8, and, due to the thickness of the overlying clay confining layer, four samples were obtained from the lower aquifer at M4.

Acetone was the only target VOC detected at MW9 (VP1) and MW10 (VP2) during the vertical profiling (Table 7). Acetone was detected at 10  $\mu\text{g/L}$  in the sample collected at a depth of 39 feet at MW9, whereas at MW10, acetone was detected at 37.7  $\mu\text{g/L}$  in the sample collected at a depth of 29 feet. Cis-1,2-dichloroethene and 1,2-dichloroethane were detected in samples collected at MW8 (Table 7). Cis-1,2-dichloroethene was indicated at a concentration of 10  $\mu\text{g/L}$  in a sample collected at 69 feet and 1,2-dichloroethane was indicated at 56.5  $\mu\text{g/L}$  (63  $\mu\text{g/L}$  with a duplicate) in a sample collected at a depth of 99 feet.

No target VOCs were detected in vertical profile samples collected at M4.

### 4.2 LABORATORY ANALYTICAL RESULTS

New lower aquifer monitoring wells were sampled at the site on March 12 to 14, 1996 for VOCs, semi-volatile compounds, PCBs and metals. Laboratory analytical results for metals are presented in Table 8. A summary of groundwater analytical results (SVOCs and metals) where there were individual exceedences of the final remediation levels (Appendix B of the SOW), is presented in Table 8B. Laboratory analytical reports from IEA for VOCs, semi-volatile compounds and PCBs are included in Appendix H, and laboratory analytical reports for metals are included in Appendix I.

#### 4.2.1 VOCs

The RI indicated that the lower aquifer was contaminated in the vicinity of monitoring well MW9. RI sampling indicated concentrations of chloroethane in the lower aquifer between

440 µg/L and 200 µg/L. The vertical profiling was conducted at the MW9 location to determine the vertical extent (depth) of contamination in the lower aquifer at this location. Monitoring well MW29 was installed specifically to sample the base of the zone of contamination. Chloroethane was estimated at a concentration of 2 µg/L (J-value) in the sample collected from MW29 during March 1996. This trace concentration is an indication that the zone of contamination extends from the base of the clay to a depth of approximately 60 feet in the lower aquifer. No other VOCs were detected in monitoring well samples (Appendix H). (Elevated PID readings were recorded in the upper few feet of the lower aquifer at monitoring well location MW10. Further investigation, as described herein, will be conducted at this point to evaluate potential downgradient effects.)

#### **4.2.2 Semi-volatiles and PCBs**

Bis(2-ethylhexyl)phthalate, for which a remediation level was defined in the SOW to the ROD, was detected in samples collected from MW29, MW30, MW32, and MW35 at concentrations ranging between 11 µg/L and 68 µg/L (Table 8B and Appendix H). This compound is a potential laboratory contaminant. It is used primarily as a plasticizer for producing plastics such as polyvinyl chloride (*Handbook of Environmental Data on Organic Chemicals, Second Edition*, Verschuere, 1983). However, since phthalates were included in the compounds with listed remediation levels in the SOW of the ROD, they will be further evaluated in the monitoring program to be started later in 1996. Phenol was detected at an estimated concentration of 6 µg/L in MW33. No other semi-volatile organics or PCBs were detected in monitoring well samples (Appendix H).

#### **4.2.3 Inorganics**

Groundwater samples from new lower aquifer wells were analyzed for total and dissolved inorganics (Table 8A). Major groundwater constituents, calcium, magnesium and sodium were detected at the highest concentrations in the lower aquifer, followed by detections of minor metal constituents, iron, potassium, manganese, and aluminum (Table 8A). Other metals were generally not detected or were found below quantitation limits ("B" designation on Table 8A).

The highest metals concentrations were generally detected at MW33 (northwest portion of the site). Several total and dissolved constituents were found in this well at levels three to five times concentrations detected in other wells at the site, including concentrations detected in nested well MW30. The highest concentrations were associated with major and minor groundwater constituents (calcium, magnesium, and sodium, iron, potassium). Manganese was detected at a level approximately three times above the remediation level for manganese. However that detection was less than three times the average concentration for the manganese detected in all new lower aquifer monitoring wells. Because of this and since MW33 is screened at the base of the lower aquifer, the occurrence of elevated manganese is likely to be natural. Other metals detected in the "totals" analyses in this were cadmium (1.4 µg/L), chromium (15.4 µg/L), cobalt (6.1 µg/L), thallium (3.8 µg/L) and vanadium (1.8 µg/L). Chromium and thallium were not detected in the "dissolved" analyses, suggesting that the occurrence of these metals was related to particulates from the aquifer, rather than from the groundwater. It is noted that the thallium concentration of 3.8

µg/L in the total metals analysis exceeded the remediation level of 0.2 µg/L listed in the SOW to the ROD.

Due to the low turbidity achieved during low flow sampling (Appendix E), most total metals analyses are directly comparable to dissolved analyses. Aluminum and iron (abundant clay mineral components) appear to be the constituents most variable between total and dissolved groundwater samples.

#### 4.2.4 Tentatively Identified Compounds (TICs)

Several TICs were detected in the volatile (VOC) and semi-volatile (SVOC) analytical results from each of the monitoring wells.

<u>Monitoring Well</u>	<u>Occurrence of TICs</u>	
MW28	VOC	None
	SVOC	One TIC at an estimated concentration of 2 µg/l
MW29	VOCs	One TIC at an estimated concentration of 5 µg/l
	SVOCs	One TIC at an estimated concentration of 3 µg/l
MW30	VOCs	None
	SVOCs	Seven TICs ranging in estimated concentration 5 to 78 µg/l.
MW31	VOCs	None
	SVOCs	Four TICs ranging in estimated concentration 2 to 11 µg/l
MW32	VOCs	None
	SVOCs	Seven TICs ranging in estimated concentration 2 to 25 µg/l.
MW33	VOCs	Six TICs ranging in estimated concentration 6 to 85 µg/l.
	SVOCs	20 TICs ranging in estimated concentration 11 to 62 µg/l.
MW34	VOCs	None
	SVOCs	Six TICs ranging in estimated concentration 3 to 27 µg/l.
MW35	VOCs	None
	SVOCs	Four TICs ranging in estimated concentration 3 to 84 µg/l.
MW36	VOCs	None
	SVOCs	One TIC at an estimated concentration of 2 µg/l

Further information is located in Appendix H, which includes the laboratory analytical results for organic analysis.

## ACS PRODUCTION WELLS

### 5.1 EVALUATION OF PRODUCTION WELLS

There are four active production wells and two abandoned production wells at the ACS site. Information regarding the status of the existing wells and recommendations for abandoning the closed wells was presented in an April 5, 1996 memorandum from Montgomery Watson to U.S. EPA. This memorandum (with a revised "recommendations" section) is included in Appendix J.

The following summarizes the status of each well:

Well No.	Status
IW1	ACS refers to this well as the <i>Reclaim Production Well</i> . All water used from this well is for make-up in a non-contact cooling water system. The well is also available for fire protection, using a booster pump.
IW2	ACS refers to this well as the <i>Boiler Well</i> . When the ACS facility was connected to the public water supply on January 8, 1996, the well was converted to an emergency back-up water supply well. This well was the primary feed well to the main office, and for the boiler system to make steam. Drinking water in the office was treated by a reverse osmosis system.
IW3	ACS refers to this well as the <i>Additives Facility Production Well</i> . Its primary use is for fire protection, using a booster pump. It is also available for minimal process use.
IW4	ACS refers to this well as the <i>Epoxol Well</i> . This well supplies process water in the Epoxol building, and also provides water for employee showers in the locker room. The water is not used as a drinking supply. A water cooler is used in the building to supply bottled water.
IW5 (Abandoned)	ACS estimates that IW5 was taken out of service in the early 1970s. This well is located near the blending facility. The surface exposure is

a two-inch diameter steel or galvanized metal pipe with a threaded cap, sticking up approximately two inches above the ground surface. The PID reading immediately upon removing the threaded cap was 43 ppm. Water was measured at a depth of approximately 3.3 feet below ground surface. During the inspection, an obstruction was encountered 3.5 feet below ground surface. ACS personnel attempted to removed the obstruction but simply pushed it a few inches deeper. Therefore, it was not possible to determine the total depth of the well. Production well IW5 may provide a direct route for contaminants to move from the upper aquifer to the lower aquifer. The well will be further evaluated and then abandoned following U.S. EPA approval of the proposed methodology included in Section 7.2.5 this technical memorandum.

**IW6  
(Abandoned)**

ACS estimates that IW6 was taken out of service in the mid 1960s. This well is located just outside the main office building at the ACS facility. The two-inch steel or galvanized pipe sticks up approximately two feet above the ground surface. A threaded cap was removed from the well. No obstructions were encountered in the well. The water level was found to be 3.4 feet below ground surface. The oil/water interface probe used to measure the depth to water did not indicate the presence of oil or free-phase liquid on top of the water. However, the probe had an oily sheen upon withdrawal from the well, indicating the presence of light, non-aqueous phase liquid (LNAPL), or that an oily substance has been placed into the well. Like IW5, production well IW6 may provide a direct route for contaminants to move from the upper aquifer to the lower aquifer. To eliminate the potential of carrying the sheen-material deeper into the aquifer, the probe was not lowered deeper in the well. Upon withdrawal from the well, the probe had accumulated a coating of white residue, where it had bumped against the inside of the casing. The well will be further evaluated and then abandoned following U.S. EPA approval of the proposed methodology included in Section 7.2.5 this technical memorandum.

## **5.2 PRODUCTION WELL SAMPLING RESULTS**

Groundwater samples were collected from the four active production wells on February 6, 1996. Laboratory analytical results are presented in Table 9 and the laboratory analytical reports are included in Appendix K.

VOCs were detected in IW1 and IW4 (Table 9). In IW1, tetrachloroethene (PCE), acetone and 2-butanone were found at concentrations at or above 10 µg/L (10 µg/L in duplicate IW1-91, 14 µg/L and 11 µg/L, respectively), and other VOCs were detected at estimated concentrations less than 10 µg/L. Other detected VOCs included 1,2-dichloroethene (total),

trichloroethene, 1,1,2-trichloroethane, bromoform, 4-methyl-2-pentanone and 1,1,2,2-tetrachloroethane. In IW4, xylene was detected at a concentration of 13 µg/L, and toluene and ethylbenzene were estimated at concentrations of 1 µg/L (J), and 4 µg/L (J), respectively (Table 9). TCE in excess of 5 µg/l would exceed the remediation level. Although PCE is not listed in Appendix B of the SOW, the concentration of 10 µg/l would exceed the MCL for PCE.

VOCs were not detected in water samples collected from IW2 and IW3. Tentatively identified compounds (TICs) were observed in groundwater samples collected from IW1, IW2, and IW4.

### 5.3 TIME-SERIES SAMPLING OF IW1

A time-series of water samples was collected from production well IW1 during continuous pumping on February 23, 1996. The objective of the time-series sampling was to evaluate how the concentrations of VOCs detected in IW1 (see Section 5.2) behaved during the continuous withdrawal of water from the well. At the start of the time-series test, the pumping rate in IW1 was set at approximately 25 gpm (as measured with a five-gallon bucket). At some time between 120 minutes and 180 minutes, the pumping rate increased to approximately 60 gpm. The reason for the increased pumping rate is unknown, but the higher rate served to increase the volume of water removed between sampling periods.

The following samples were collected during the time-series test:

Sample Time	Time Since Pumping Began (minutes)	Pumping Rate (gpm)	Incremental Volume Removed (gal)	Total Volume Removed (gal)
0835	0 - Start pump	0	0	0
0850	15	25	375	375
0905	30	25	375	750
0935	60	25	750	1,500
1035	120	25	1,500	3,000
1135	180	60*	2,725*	5,725*
1300	265	60	5,100	10,825
1445	370	60	6,340	17,165
1635	480	60	6,600	23,765

\* Pumping rate estimated to increase from 25 gpm to 60 gpm at 1100.

Field GC analytical results for the time-series samples are presented in Table 10. PCE and TCE were detected in samples collected up to 60 minutes after pumping was initiated. The concentration of PCE and TCE increased from 15 to 30 minutes, then decreased with additional pumping. TCE was detected last at 60 minutes (5 µg/l) and was not detected during the rest of the test. After 60 minutes of continuous pumping, PCE was detected in the 120-minute, 180-minute, and 480-minute samples at concentrations of 7.4 µg/L, 5.2 µg/L and 5.3 µg/L, respectively. Based on the detection of PCE at 480 minutes near the reporting limits (5 µg/L for the field GC), it is likely that PCE concentrations stabilized at or below the 5 µg/L method reporting limit during the period between 180 and 480 minutes.

The time-series sampling results indicate that the water pumped from IW1 contains low levels (generally <10 µg/l) of TCE and PCE. It appears that the cumulative concentration in water extracted from the well is approximately 5 µg/l. The immediate source of the contamination may be the bedrock aquifer in the vicinity of the open hole. However, the original and probable ongoing source is the upper aquifer, via the well annulus. Once the well is properly abandoned as described herein, this possible source will be eliminated.



## PRIVATE WELLS

### 6.1 PRIVATE WELL SEARCH

In an effort to identify all private wells in the vicinity of the ACS site (as discussed in the Upper Aquifer Technical Memorandum), several sources of information were consulted. The Lake County, Indiana Health Department and the Griffith Public Works Department were contacted for information on wells in the area, and well logs were obtained from the Indiana Department of Natural Resources (IDNR).

The well search built on the well location information presented in the RI report and Upper Aquifer Technical Memorandum. It was prepared by Environmental Data Resources, Inc. (EDR, a commercial database service). Well locations were plotted from an August 1996 water well records list obtained by Montgomery Watson from the Indiana Department of Natural Resources (IDNR). EDR combined several well locations under a single well symbol in areas of the map that contained many wells. The EDR data base is included in Appendix L. To facilitate viewing, the multiple well locations in the direct vicinity of the ACS Site have been hand plotted to show the separate well locations. During the Lower Aquifer Investigation, Montgomery Watson conducted a door-to-door survey of residential and industrial properties along Colfax Avenue, South Arbogast Avenue, and Reder Road to identify wells that were not included in the IDNR data base. Identified wells were hand-plotted and shown on the Well Search Map (Figure 8). Table 11 lists these field identified water wells.

The Lake County Health Department does not have information on private well locations. According to the Griffith Public Works Department, ACS and the Griffith Public Works Garage have been connected to the municipal water system. Water main locations were obtained from the Town of Griffith Public Works Department and are plotted on Figure 8 to provide an indication of areas that may use private wells. Other homes and businesses along South Colfax Avenue and Main Street in the vicinity of ACS, and along Reder Road, Arbogast, and Avenue H have not been connected to municipal water, and are therefore served by private wells. It appears that most of the residential and business districts north and west of the ACS facility are supplied water by the Griffith municipal supply.

Based on the dimensions of the VOC plume in the upper aquifer, these well locations may have been susceptible to potential VOC migration along the well casing from the upper to lower aquifer. Two of the wells are located within the area of identified upper aquifer contamination (wells A and H on Table 11; Figure 8), and two wells are located outside the zone but near the zone of contamination (wells M and O on Table 11; Figure 8). Water samples from the four wells were analyzed for full scan TCL/TAL list.

Because other private wells identified in the area are located beyond the limits of upper aquifer contamination presented in the Upper Aquifer Technical Memorandum, other wells were not included in the sampling plan at this time.

## 6.2 PRIVATE WELL SAMPLING RESULTS

Eight residential wells were sampled during the Remedial Investigation in 1991 and the results were reported in the Remedial Investigation Report. Four residential wells were sampled on July 17, 1996 for VOCs, semi-volatile compounds, PCBs and metals. Split samples were collected from each residential well by a U.S. EPA representative. Laboratory analytical results for VOCs and SVOCs are presented in Table 12. Metals results are summarized in Table 13. Laboratory analytical reports from IEA for VOCs, semi-volatile compounds and PCBs are included in Appendix M, and laboratory analytical reports for metals are included in Appendix N. Groundwater samples collected for semi-volatiles and PCBs from residential well PW01 (1002 Reder Road) were lost during shipment by Federal Express. Therefore, results from PW01 for semi-volatiles and PCBs are not available.

Residential well sample identification numbers correspond with the following addresses:

<u>Well Identification</u>	<u>Address</u>
PW01 (A)	1007 Reder Road
PW02 (H)	938 Arbogast
PW03 (M)	940 Arbogast
PW04 (O)	430 East Avenue H

### 6.2.1 VOCs

Chloroethane (21 µg/L) and benzene (1 µg/L) were detected in private well PW02. No VOCs were detected in the other three wells sampled: PW01, PW03, or PW04 (Table 12). The residence at PW02 is connected to the Town of Griffith water supply and therefore, the well that was sampled is not used as a drinking water well.

### 6.2.2 Semi-Volatile and PCB Results

Bis(2-ethylhexyl)phthalate was detected in the sample collected from PW03 at a concentration of 12 µg/l. The occurrence of this compound is considered to be laboratory related. Several semi-volatile tentatively identified compounds (TICs) were detected in

PW02 (20 TICs) and PW03 (5 TICs). No PCBs were detected. The semi-volatile analytical results are summarized on Table 12.

### **6.2.3 Inorganic Results**

Groundwater samples from the residential wells were analyzed for total and dissolved metals (Table 13). Major groundwater constituents, calcium, magnesium, and sodium, were detected at the highest concentrations in the residential wells, followed by detections of minor constituents barium, copper, iron, manganese, and potassium (Table 13). Other metals were generally not detected or found below quantitation limits ("B" designation on Table 13).

The highest metal concentrations were observed in PW02 (938 Arbogast). Several total and dissolved constituents were found in this well at levels considerably higher, depending on constituent, than the other three wells. The highest concentrations were associated with the major constituents calcium, magnesium, sodium, and potassium. Other constituents such as nickel (51 µg/L) and silver (10.5 µg/L) were not detected in the other three wells. These results indicate that the water from PW02 contains higher dissolved solids than the residential wells that were sampled. This could be due to many possible reasons, including a malfunctioning pump, poor filter pack, or leakage from the upper aquifer in this location. The residence at PW02 is connected to the municipal water supply so this well is not used as a drinking water source.

Total and dissolved metals concentrations generally are comparable. Barium, calcium, iron, magnesium, manganese, potassium, and sodium appear to be the constituents most comparable between total and dissolved metal concentrations. In the future, only total metals analyses will be conducted on samples. Dissolved metals concentrations will not be analyzed.

## CONCLUSIONS AND RECOMMENDATIONS

### 7.1 CONCLUSIONS

Lower Aquifer Investigation activities implemented during January, February and March 1996 at the ACS NPL site consisted of the following:

- Using a rotosonic drilling method to obtain continuous core samples to evaluate the stratigraphy of the lower aquifer;
- Vertical profiling across the lower aquifer at four locations, and field GC analysis of groundwater samples for target VOCs, to detect any zones of VOC contamination in the lower aquifer;
- Installation of nine monitoring wells and three piezometers in the lower aquifer at six locations;
- Sampling of nine new lower aquifer monitoring wells for full scan TAL/TCL (VOCs, semi-volatiles, PCBs, and metals);
- Measurement of water levels in the new wells and piezometers in the lower aquifer to determine horizontal and vertical gradients;
- Measurement of continuous water levels in two monitoring wells and one piezometer for approximately 30 days;
- Evaluation and sampling of current ACS production wells for VOCs;
- Chemical time-series sampling of ACS production well IW1 and analysis with the field GC;
- Inspection of two abandoned ACS production wells;
- Identification of private residential wells within a 2-mile radius of the ACS facility

The following conclusions are based on the data developed from these activities:

1. The stratigraphy of the unconsolidated aquifers at the ACS site consists of upper and lower sand aquifers separated by a clay confining layer.
2. The upper clay confining layer varies in thickness from 35 feet to the south to 2.5 feet to the north. The top of the clay is found at elevations between 618 and 622 feet amsl on site.
3. The lower aquifer was determined to consist of well sorted gray to brown fine sand which varies in thickness at the ACS site between 40 to 68 feet. Delineation of lower aquifer stratigraphy meets Objective #1 established for the Lower Aquifer Investigation.
4. The lower clay confining layer was found to be 12 to 20 feet thick at an elevation between 540 and 550 feet amsl at two locations. Bedrock consists of dark gray shale at an elevation of 527 to 538 feet amsl.
5. The vertical hydraulic gradient in the lower aquifer was less than or equal to 0.001 from upper to lower portions of the aquifer, as indicated by water levels collected at lower aquifer monitoring wells and piezometers on March 15, 1996.
6. The direction of groundwater flow in the lower aquifer is northward under a hydraulic gradient of 0.00047. The direction of groundwater flow and hydraulic gradient are consistent with those for the June 1991 RI and the October 1995 Technical Memorandum. Determination of horizontal and vertical gradients meets Objective #4 set forth in the SOW for the Lower Aquifer Investigation.
7. Although potential VOC contaminants were indicated by the vertical profiling at two lower aquifer points (MW8, MW10), it was not confirmed by the sampling of monitoring wells that were installed at these points. The elevated PID readings observed in the upper portion of the lower aquifer indicated the potential for contamination at the MW10 location. Installation of a new lower aquifer monitoring well is proposed at the MW10 nest to address this potential for contamination. The new well will replace existing monitoring well MW10 in the Monitoring Plan.
8. Bis(2-ethylhexyl)phthalate was detected in samples collected from MW29, MW30, MW32, and MW35 at concentrations ranging between 11 µg/L and 68 µg/L. No other semi-volatiles or PCBs were detected above quantitation limits in monitoring well samples.
9. Major groundwater inorganic constituents (calcium, magnesium, sodium, iron, and potassium) were detected at the highest concentrations in the samples from the lower aquifer. Chromium and thallium were detected in the "totals" analyses

at the base of the lower aquifer in monitoring well MW33, but these metals were not detected in the "dissolved" sample analyses. Other metals were generally not detected, found below quantitation limits, or were below the remediation levels listed in the SOW to the ROD.

10. The detection of only trace levels (estimated 2 µg/L) of chloroethane at MW29 indicates that the zone of known contamination indicated at MW9 in the RI, extends to a depth of approximately 60 feet in the lower aquifer (vertical gradient component of Objective #3).
11. Elevated PID readings just below the base of the confining clay (613 ft amsl) to approximately 10 ft into the lower aquifer (603 ft amsl) at the MW10 location may indicate the presence of constituents in the lower aquifer at this downgradient location.
12. A zone of upper aquifer contamination was better delineated during the Upper Aquifer Investigation. Chloroethane and benzene were detected at levels below remediation levels and MCLs at private well PW02, which appears to be drilled through the zone of upper aquifer contamination. An additional lower aquifer well will be installed downgradient of the PW02 location to evaluate the lower aquifer in this area.
13. Although NAPLs are known to exist in the upper aquifer, the findings of the lower aquifer investigation did not provide evidence for the presence of DNAPLs in the lower aquifer (Objective #5). The presence of DNAPLs might have been indicated by either: 1) observations of DNAPL during coring, vertical profiling or monitoring well sampling; or 2) detections of elevated concentrations of contaminants during groundwater sampling in the lower aquifer (resulting from dissolution of DNAPL product into the groundwater). The presence of a sheen was observed during the inspection of IW6, may indicate the potential for the presence of LNAPLs.
14. VOC concentrations were found in lower aquifer water samples collected from two ACS production wells (IW1 and IW4). A water sample collected from IW1 contained acetone and 2-butanone at 14 µg/L and 11 µg/L, respectively. Xylene was detected in a water sample from IW4 at 13 µg/L. Estimated concentrations of several VOCs were detected in water samples collected from both wells at individual concentrations less than the detection limit of 10 µg/L.

## **7.2 RECOMMENDATIONS**

### **7.2.1 Horizontal Extent Downgradient of Site**

Elevated PID readings observed below the confining clay at the monitoring well MW10 location indicate the potential for contamination in the lower aquifer. No well was installed at this depth during the investigation because MW10 was screened from 10 to 15 ft below the confining clay layer. A new monitoring well is proposed at this location, with a ten-foot screen across the portion of the lower aquifer (613 ft to 603 ft amsl) where the elevated PID readings were observed.

The monitoring well will be constructed in accordance with the Statement of Work (SOW) and Specific Operating Procedures (SOPs) approved for the previously installed lower aquifer monitoring wells. The new well will replace existing monitoring well MW10 in the quarterly monitoring program to provide ongoing confirmation of compliance, or provide an indication of future contaminant migration.

### **7.2.2 Vertical Extent at the MW9 Well Nest**

The detection of a trace level of chloroethane at MW29 (2 µg/L) in the March 1996 sampling (Appendix H), indicates that MW29 is positioned at the lower extent of contamination in the lower aquifer. Monitoring wells MW9 and MW29 will be included in the quarterly monitoring program to provide future indications of compliance or contaminant migration in the lower aquifer at this location. The March 1997 sample from MW9 will be analyzed on an expedited basis. The results of the sampling and a plan for further investigation will be submitted to U.S. EPA by April 30, 1997.

### **7.2.3 Character of Lower Aquifer Contamination**

The nature of the contamination in the lower aquifer at the site has been defined to date by the chloroethane detected at monitoring well MW9, chlorinated ethenes and xylenes detected in the samples from the ACS production wells IW1 and IW4, and the oil sheen observed in production well IW6.

There have been previous discussions with the U.S. EPA regarding the viability of installing additional lower aquifer wells within the ACS boundaries. Given the very high levels of contamination and the presence of non-aqueous phase liquids (NAPLs) within the site boundaries, and given the strong downward gradient between the upper and lower aquifer, we believe that any decision regarding installation of new lower aquifer wells within the Site boundaries should be deferred until after the upper aquifer groundwater treatment systems are in place and operational. When the treatment systems are operational, the highly contaminated areas will be dewatered and the dewatering will eliminate the strong downward gradient from the upper to the lower aquifer.

### **7.2.4 Potential Lower Aquifer Contamination in the Vicinity of Plume to Southeast**

During the Upper Aquifer Investigation, samples were analyzed by field GC as an indicator of the extent of the plume in the upper aquifer extending south-southeast from the intersection of Reder Road and Colfax Avenue. Upper aquifer monitoring wells have been

installed to confirm the extent of this plume and to monitor its future behavior. A new lower aquifer well will be installed downgradient of the PW02 location to evaluate the lower aquifer 100 to 200 feet north of PW02. The monitoring well will be constructed in accordance with the Statement of Work (SOW) and Specific Operating Procedures (SOPs) approved for the previously installed lower aquifer monitoring wells. The monitoring well will be included in the quarterly monitoring program to provide ongoing confirmation of compliance, or provide an indication of future contaminant migration.

### **7.3 ACS PRODUCTION WELLS**

Investigation and sampling results indicate that four active production wells (IW1, IW2, IW3, and IW4) and the two closed production wells (IW5 and IW6) may present migration routes for contaminants between the upper and lower aquifers. Therefore, after further investigations, the six production wells will be abandoned in accordance with the Indiana Administrative Code regarding well abandonment, 310 IAC 116-10-2.

#### **7.3.1 Production Wells IW1, IW2, IW3, and IW4**

The pump, the piping, and the wiring will be removed from the each well. Then the following investigations will be conducted at each of the four well locations.

##### **7.3.1.1 Sounding Measurements**

**Total Depth.** After the pumps have been removed, the total depth of each well will be measured with a steel tape or well sounding device. It is possible that obstructions will be encountered in the open hole portion of the well. In such a case, the total depth to the obstruction will be measured.

**Static Water Level.** It is expected that the water levels in the production wells will be representative of the bedrock aquifer. Water levels will also be collected in monitoring wells MW7, MW8, and MW9 to represent the lower alluvial aquifer, and in piezometers P29, P32, P34, P36, and P39 to represent the water table aquifer. Water levels will be collected from IW5 and IW6 as discussed below, and if access is granted by the Town of Griffith, a water level will be collected at M4D. There will be at least a 15 minute delay between the time the pump and piping are removed from the well and the static water level is measured. This will be sufficient time for the water level in the well to have stabilized.

All the water levels will be collected within a four-hour time span to provide concurrent water levels in the bedrock aquifer, the lower alluvial aquifer, and upper alluvial aquifer. Water levels will be measured and recorded for each of the four production wells. The reference elevation (top of casing), will be established to within 0.01 foot by a surveyor so that the water levels can be translated into groundwater elevation in feet above mean sea level.



### **7.3.1.2 Well Logging**

**Caliper Log.** A caliper log will be used primarily to identify the end of the casing and beginning of the open hole in the bedrock. It may be that the open hole below the casing is not a clean cylindrical borehole. The rock may be highly fractured, differentially enlarged, or obstructed. Therefore, caliper log will also be useful in determining the practicality and methodology for logging the entire well from the base of the open hole up through the casing.

**Natural Gamma Log.** The objective of using the natural gamma log will be to identify the depths of the transitions and the thicknesses of the upper aquifer, the upper confining clay layer, the lower alluvial aquifer, the lower confining clay layer, and the bedrock. Assuming that the caliper log indicates logging the open borehole will be practicable, the natural gamma log will also be used to log that portion of the well.

### **7.3.1.3 Sampling**

The four active production wells, IW1, IW2, IW3, and IW4 were sampled during the lower aquifer investigation in February 1996. The samples collected from IW1 contained low concentrations of PCE and TCE. The sample collected from IW4 contained low levels of toluene and xylenes. (VOCs were not detected in wells IW2 and IW3). We do not believe that these concentrations are representative of the contamination in the bedrock aquifer. Rather, we suspect that the source of the VOC contamination is leakage from the upper aquifer, along the annulus of the well, or possibly from the well pumping system itself.

The most likely entry point for the contaminants is at the base of the casing where it is seated in the bedrock (a depth of 131 feet according to the available well log). The samples were collected by the pumps which exist within the wells, after purging several hundred gallons from each well. The sample results are representative of the average quality of the bedrock aquifer, plus whatever is leaking down the annulus or coming from the pumping system.

If the caliper log indicates that there is good continuity between the casing and the bedrock and that there is not a zone of highly disturbed bedrock, a packer will be lowered into the well to seal off the bedrock zone below the casing. The water in the casing will then be purged, and sample collected from above the packer, following the low flow sampling SOP included in Appendix O.

If the caliper log indicates a highly disturbed bedrock zone beneath the casing so that there would be a danger of losing the packer unit in the borehole, a sample will be collected without the packer, using the low flow sampling methodology described in the SOP included in Appendix O.

Three samples will be collected from the production wells for TCL and TAL analyses. One sample volume will be provided to U.S. EPA for a split sample. The second sample volume will be sent to a laboratory for analysis. The third sample will be stored at 4°C in an on-site refrigerator pending receipt of the second sample by the laboratory. Once the

laboratory has confirmed that they have all the sample containers and are able to extract the appropriate sample volumes for analysis, the third sample will be discarded.

This sampling process will be conducted at each of the ACS wells drawing water from the bedrock aquifer. Upon completion of the sampling and verification that the laboratory has received the sample containers intact, the wells will be abandoned in accordance with Indiana guidance regarding water well abandonment, 310 IAC 16-10-2.

#### **7.3.1.4 Abandonment**

The detection of low levels of VOCs in samples from two of the ACS bedrock wells indicate that the wells are acting as conduits from the upper aquifer to the deeper aquifers. To eliminate the potential for future contaminant migration along the well casings, the four ACS wells will be abandoned. The concept of the abandonment includes sealing the open hole in the bedrock by filling it with grout, and then sealing the annulus of the well in the most vulnerable zone. The most vulnerable zone is from the base of the upper clay layer, approximately 20 feet down into the lower aquifer. The abandonment will be conducted in the following steps:

- A tremie pipe will be lowered as far as possible into the well. Assuming that there are not obstructions, this will be to the bottom of the open borehole in the bedrock.
- Grout will be injected from the bottom of the borehole via the tremie, filling the open hole and bringing the grout up into the casing to within 40 feet of the base of the upper clay.
- The rig will move on to the next well, allowing the injected grout to set up.
- When the grout has setup in the lower part of the well, a perforating tool will be lowered into the casing, to make 10 perforations, approximately 1/2 inch in diameter, through the casing just above the grout. The perforations will be made around the circumference of the casing, along approximately a two-foot length.
- Another similarly arrayed set of 10 perforations will be made two to four feet above the base of the upper clay confining layer.
- A packer will be placed down the well and expanded to seal it just above the lower set of perforations.
- Water will be injected into the packed-off section of the casing. Flow of water through the upper perforations will demonstrate continuity in the zone to be grouted. If water flow is not induced, the packer will be withdrawn and more perforations will be made. Then the packing and water injection will be repeated.

- When water flow demonstrates continuity, a grout mixture will be injected through the packed-off zone, until the consistency of the returned grout indicates that full strength grout has filled the annulus between the two sets of perforations.
- The rig will move on to perforate and grout the remaining wells.
- The rig will return to the first location and fill the remaining casing with grout, and cap it in accordance with 310 IAC 16-10-2. These steps will be repeated at each of the remaining bedrock production wells.

### **7.3.2 Closed Production Wells IW5 and IW6**

Production wells IW5 and IW6 were closed by ACS Inc., by extending the existing two-inch casings above ground surface and capping. The static water levels in both IW5 and IW6 is approximately 3.5 feet below ground surface. Well IW5 has an obstruction approximately 5 feet below ground surface. A sheen on the water level probe inserted into well IW6 indicates the presence of a free-phase liquid.

The obstruction in IW5 is partial, in that it does not block the movement of liquids. The first step in the investigation of IW5 will be to use fishing tools to try to remove the obstruction. With the presence of a work-over rig on site, more finesse and more force can be brought to bear than previously to clear the obstruction. The first step in further investigating IW6 will be to lower a transparent bailer below the water surface and draw it out to determine if there is floating free-phase product in the well. If free product is identified in the bailer, a single sample will be submitted for laboratory analysis of TCL parameters.

#### **7.3.2.1 Level and Depth Measurements**

As described in section 1.1.2, the static water levels will be measured in each well, IW5 and IW6. In addition, the total depth of each well will be measured (assuming that the obstruction has been cleared from IW5).

#### **7.3.2.2 Well Logging**

The natural gamma log will be used to provide an indication of the depth to and the total thickness of the clay confining layer between the upper and lower aquifer. If it is not possible to clear the obstruction from IW5, it will not be possible to perform the natural gamma log.

#### **7.3.2.3 Sampling**

The total volume of each casing will be calculated from the results of the depth measurements. Two casing-volumes of water will be bailed from each well with disposable bailers. The water will be bailed from the top five feet of the casing, to draw fresh water in from the bottom of the casing. (Even if it has not been possible to remove the obstruction from IW5, this method will still allow purging and sampling of the well.) The sampling will not be conducted with a pump because it is likely that the high level of contamination in wells IW5 and IW6 would destroy the pump.

After purging two casing volumes from the well, sample volumes of the water from IW5 and IW6 will be collected for laboratory analysis of the Target Compound List (TCL) organics. Additional sample volumes will be provided to U.S. EPA for a split sample and to store until laboratory verification that they have received all sample containers and have adequate extraction volumes. Since the obstruction is approximately five feet below ground surface in IW5, this procedure will allow sampling even if it has not been possible to remove the obstruction.

#### **7.3.2.4 Abandonment of IW5 and IW6**

After samples have been collected, IW5 and IW6 will be permanently abandoned by the following methods.

**Over drilling and Grouting.** The existing two-inch casing will be overdrilled by a drilling rig equipped with a 10-inch inside diameter hollow-stem auger. The casing will be overdrilled to a depth of at least two feet into the confining clay layer between the upper alluvial and lower alluvial aquifer. The depth to and thickness of the clay will have been determined by the natural gamma logging. The augers will be withdrawn from the borehole, and the borehole will be filled from the bottom with grout. The rig will move on to the next location, while the grout sets up.

#### **Remove Existing Casing**

Upon overdrilling well at the second location, the rig will return to the first location and pull the two-inch casing out of the hole. The casing will be steam cleaned and disposed of as scrap metal.

#### **Grout to Surface**

A tremie pipe will be lowered as far down into the clay confining layer below the casing as possible and the eight-inch casing will be filled from the bottom with grout. Groundwater that overflows as the hole is filled with grout will be placed in drums and allowed to settle. After grout and particulate matter has settled out, the water will be processed through the construction de-watering water treatment system.

After the first of the two casings has been grouted, the rig will move on and perform the same abandonment procedure on the second well

### **7.4 LOWER AQUIFER MONITORING PLAN**

The second round of groundwater sampling includes 24 monitoring wells in the lower aquifer. The specific wells and laboratory analyses are listed in Table 14. (The locations and parameters of the upper aquifer monitoring well included in the groundwater monitoring plan are listed in Table 7 of the Upper Aquifer Technical Memorandum). All sampling will be conducted in accordance with U.S. EPA approved Specific Operating Procedures (SOPs).

Monitoring well MW10, installed during the Remedial Investigation, was completed with a five-foot screen, located approximately five feet below the top of the lower alluvial aquifer. Monitoring well MW51 was installed adjacent to MW10 but completed with a ten-foot screen, across the upper ten feet of the lower alluvial aquifer. MW51 replaces MW10 in the ACS monitoring network.

#### **7.4.1 Water Level Measurements**

Water levels will be collected at each well in the upper aquifer monitoring plan and in each lower aquifer monitoring well and piezometer, prior to sampling any of the wells. All the water levels will be collected in a single day to minimize the potential water variability with time.

#### **7.4.2 Baseline Sampling**

A lower aquifer water quality baseline will be established by sampling 24 lower aquifer wells for four consecutive quarters starting in October 1996. The first "round" of sampling for the baseline consists of the full-scan sampling of the new lower aquifer wells in March, the residential well sampling in July, and the proposed sampling of the previously existing lower aquifer wells in October. Additional rounds of sampling will be conducted in the first, second, and third quarters of 1997 to complete the baseline. The proposed locations and parameters for the next round of sampling in March 1997 are summarized in Table 14. The samples collected from monitoring well MW9 have showed increasing concentrations of benzene and chloroethane. Therefore, the analysis on the groundwater collected from this well will be analyzed on an expedited basis and reported to U.S. EPA by April 30, 1997.

#### **7.4.3 Residential Well Drinking Water Sampling**

Nine residential wells have been identified along Reder Road, as well as the six residential wells listed above by U.S. EPA. Samples will be collected from the following 15 residences as soon as access can be arranged with the individual homeowners or residents.

1000 Reder Road	739 Arbogast
1007 Reder Road	1008 Arbogast
1009 Reder Road	1014 Arbogast
1029 Reder Road	1026 Arbogast
1033 Reder Road	430 Avenue H
1043 Reder Road	1009 Wood Street
1044 Reder Road	
1046 Reder Road	
1048 Reder Road	

The samples will be collected in accordance with the approved SOP for residential well sampling (Appendix P). Each sample will be analyzed for full scan TCL and TAL parameters. Following review of these analyses, U.S. EPA will recommend a plan for future residential monitoring.

KJS/PJV/PRP/TAB/PJV

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**Table 11**  
**Field Identified Wells**  
**American Chemical Service, Inc.**  
**Griffith, Indiana**

<b>Well Designation *</b>	<b>Well Usage/Owner</b>	<b>Well Location (Address)</b>
A	Residential Well	1007 Reder Road
B	Residential Well	1009 Reder Road
C	Residential Well	1029 Reder Road
D	Residential Well	1033 Reder Road
E	Industrial - M&R Truck Repair	1045 Reder Road
F	Industrial Usage - Clean Cities Recycling	1010/1012 Reder Road
G	Production Well - Weldco	1020 Reder Road
H	Residential Well	938 Arbogast
I	Production Well - Aeromet	739 South Arbogast
J	Residential Well	1008 South Arbogast
K	Residential Well	1014 South Arbogast
L	Residential Well	1026 South Arbogast
M	Residential Well	940 South Arbogast
N	Residential Well	420 Avenue H
O	Residential Well	430 Avenue H
P	Production Well - ACS	420 South Colfax
Q	Production Well - ACS	420 South Colfax

Note:

\* Well designations correspond with letters noted on EDR "Well Search" map.

**Table 14**  
**Lower Aquifer Monitoring Plan**  
**American Chemical Service, Inc. NPL Site**  
**Griffith, Indiana**

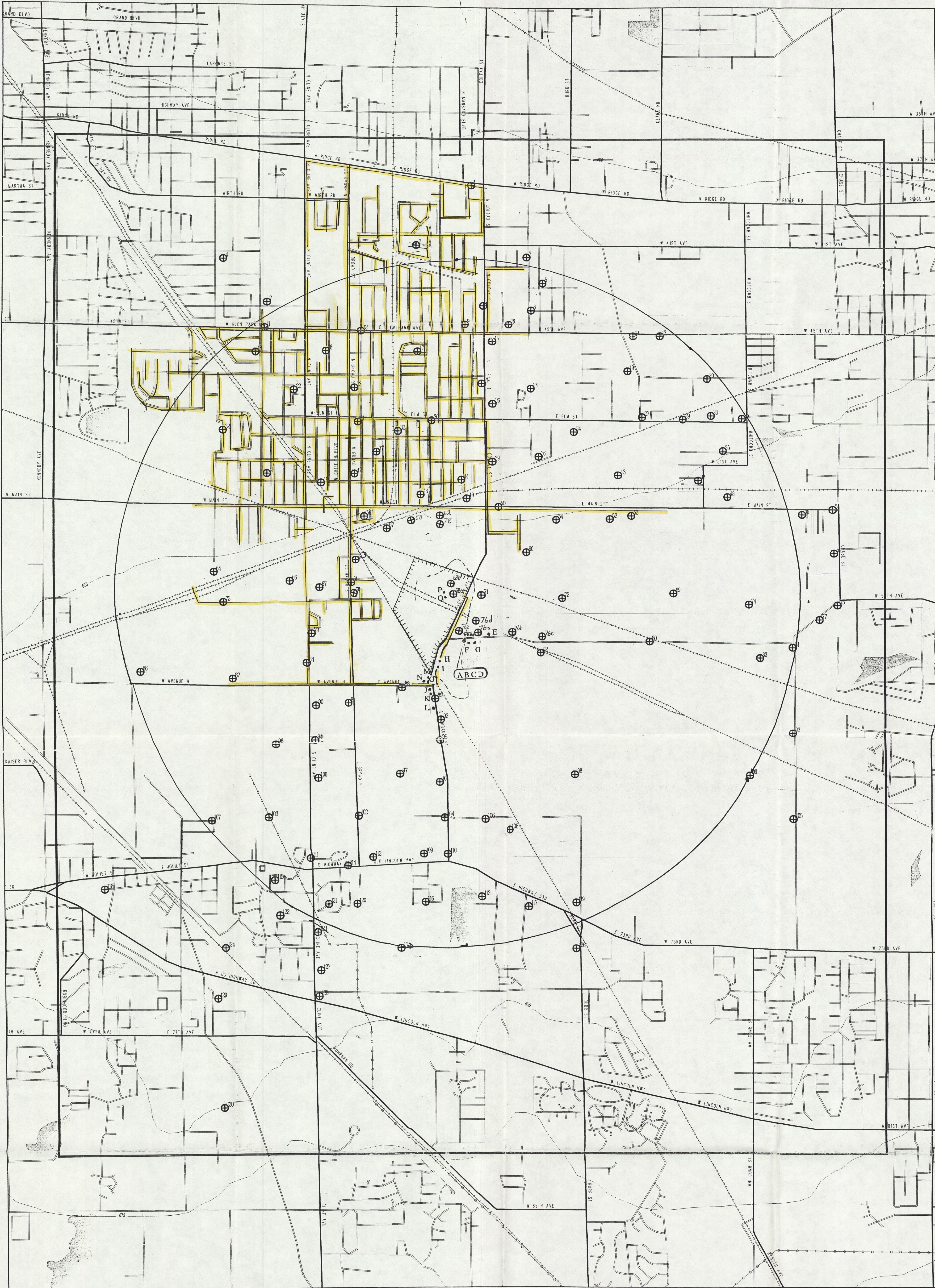
	Well Identification	Piezo-meter	Well Screen Depth in Lower Aquifer	Site Location	Completed in 1996		1997
					March	Dec	March
1	MW24		Upper	Downgradient		TAL/TCL	TAL/TCL
2	MW52		Upper	Downgradient		TAL/TCL	TAL/TCL
3	MW53		Lower	north of site		TAL/TCL	TAL/TCL
4	MW51		Upper	Downgradient		TAL/TCL	TAL/TCL
5	MW30		Middle	north of site	TAL/TCL		TAL/TCL
6	MW33		Lower		TAL/TCL		TAL/TCL
7	MW54		Upper	Downgradient		TAL/TCL	TAL/TCL
8	MW55		Lower	north of site		TAL/TCL	TAL/TCL
9	MW8		Upper	Downgradient		TAL/TCL	TAL/TCL
10	MW31		Middle	North	TAL/TCL		TAL/TCL
11	MW32		Lower		TAL/TCL		TAL/TCL
12	MW10C		Upper	Downgradient		TAL/TCL	TAL/TCL
13	MW23		Upper	Downgradient		TAL/TCL	TAL/TCL
14	MW9		Upper	Downgradient		TAL/TCL	TAL/TCL
15	MW29		Middle	west of site	TAL/TCL		TAL/TCL
16	MW34		Lower		TAL/TCL		TAL/TCL
17	M4		Upper	Griffith Landfill			TAL/TCL
18	MW35		Lower		TAL/TCL		TAL/TCL
19	MW21		Upper	Side-gradient		TAL/TCL	TCL
20	MW7		Upper	Site-gradient		TCL	TCL
		PZ44	Middle	east of site			
21	MW36		Lower		TAL/TCL		TAL/TCL
22	MW28		Upper	Upgradient	TAL/TCL		TAL/TCL
		PZ42	Middle	east of site			
		PZ43	Lower				
23	MW22		Upper	Upgradient	TAL/TCL		TAL/TCL
24	MW50		Upper	south of site		TAL/TCL	TAL/TCL

Notes:

TCL Target Compound List (VOCs, SVOCs, pesticides & PCBs)

TAL Target Analyte List



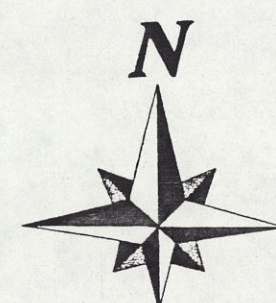


**EDR** Environmental Data Resources, Inc.  
 Creators of Toxichack  
 1-800-352-0050

0 1/4 1/2 1  
 Scale in Miles

# Well Search For ACS NPL SITE

**FIGURE 8**



- |                     |             |               |                 |                                                                              |                                                  |
|---------------------|-------------|---------------|-----------------|------------------------------------------------------------------------------|--------------------------------------------------|
| Listed Wells        | Major Roads | Contour Lines | Fault Lines     | Field Identified Wells (wells not included in database but located in field) | Approximate Limits of VOC Plume in Upper Aquifer |
| Study Area Boundary | Waterways   | Pipelines     | Water           | Water Mains                                                                  | Approximate Site Boundary                        |
| Roads               | Railroads   | Powerlines    | Superfund Sites |                                                                              |                                                  |